OPERATING AND SERVICE MANUAL

8000 SW TRANSDUCER INDICATOR

BLH ELECTRONICS
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TM 8000 SW-2

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PATENT INFORMATION

BLH Equipment is manufactured under one or more of the following patents:

2,771,579	*3,083,689*	*3,405,359*	*3,554,503*
2,815,480	*3,085,847*	*3,434,343*	*3,600,670*
2,846,645	*3,334,352*	*3,434,453*	*3,617,878*
2,932,776	*3,350,927*	*3,438,056*	*3,667,041*

Patented in Canada 1955, 1958, 1960, 1966, 1967, 1968, 1970.

BLH ELECTRONICS,

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8000 SW
TRANSDUCER
INDICATOR

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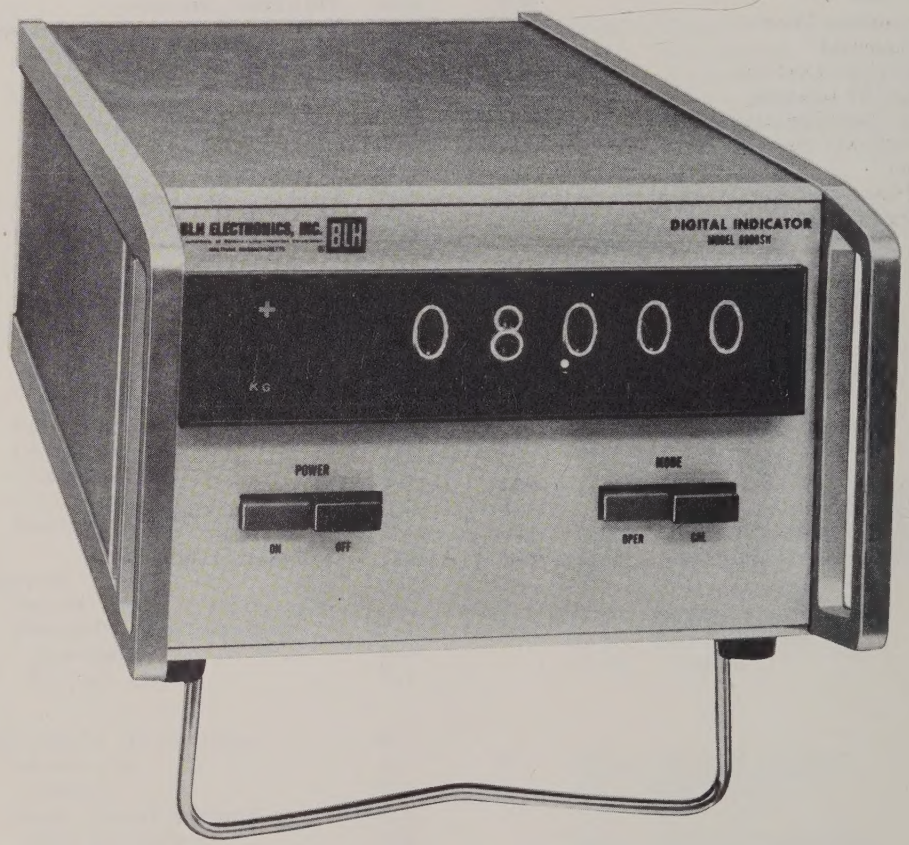


Figure 1-1. 8000SW Transducer Indicator

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. General.

1-3. This manual contains the basic installation, calibration, operation and maintenance instructions for the BLH Model 8000SW Transducer Indicator. The manual is for use on both the operator and technician level as an operating, overhaul, and service document. Section I covers instrument specifications and general information; Section II, Installation, including power and signal connection information; Section III, Operation, Section IV, Theory; Section V, Maintenance; and Section VI, Replaceable Parts.

1-4. Description.

1-5. The basic Model 8000SW, Figure 1-1, is essentially a solid state digital voltmeter designed for use with BLH Switching Units. Bridge excitation voltage generated by the Model 8000SW is 10.00 Vdc at 350mA. The single or summed millivolt - per - volt signal output from the switching unit is amplified and converted to a digital readout through ICs mounted on plug-in circuit boards. These boards include standard and optional amplifiers, power supplies, filters and converters. Rear panel connectors and terminal boards are provided to interface system power and signal functions with external equipment. Readout is illuminated digital display and/or BCD.

1-6. Characteristics.

1-7. The accuracy of the Model 8000SW is 0.02% of reading ± one count between 67 and 77 degrees Farenheit. Signal input to readout ratio is 1.0 mV/V = ± 5.0V (10,000 counts). Measuring speed (sample rate) is three readings per second, externally variable to one reading in two seconds. Digital display consists of seven 5/8 inch gas lonization tubes. Five tubes are active. A ± polarity tube and a dummy zero (optional), complete the display. The instrument will store and display on external command the last reading indicated, including the polarity sign. The least significant digit of the display is programmed to count by 1's, 2's, or 5's depending upon instrument application; resolution is 0.01%, 0.02% and 0.05%, respectively. Decimal points can be displayed at selected locations in the display by internal or external control. Complete specifications for the unit are listed in Table 1-1.

1-8. Controls.

1-9. There are two pushbutton switches on the front panel of the Model 8000SW. The switches place the instrument in the calibrate or operate mode and apply primary power. The BRIDGE ZERO and AMPLIFIER SPAN controls are located on the associated switching unit and are used to set the initial, unloaded, zero level of the transducer network and full scale transducer output trim respectively. A complete description of instrument controls and functions is included in Section II of this manual and the switching unit manual.

1-10. Options.

1-11. The following options are available for use with the basic instrument:

OPTION 01. DUMMY ZERO: Provides an extra, non-functional, digit for matching actual measured quantity to capability of voltmeter. e.g. Actual load = 100,000 pounds. Transducer output at full load is 1 mV/V or 10,000 counts on the digital display. Addition of the dummy zero will result in a digital display of 100,000 counts.

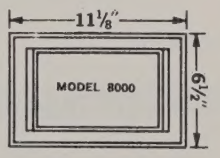
OPTION 02. DIGITAL SCALING: Multiplier circuit provides the following displays:
10,000 counting by 1 (standard)
20,000 counting by 2
30,000 counting by 3
40,000 counting by 4
(up to 90,000 counting by 9)

OPTION 03. ACTIVE FILTER: Eliminates pulsating or cyclic load induced signals.

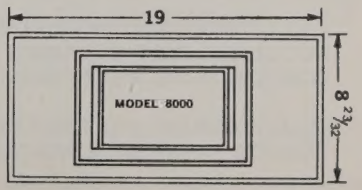
OPTION 04. BCD OUTPUT: 5 BCD 1-2-4-8 digits plus single bit polarity.

OPTION 06. LEAST SIGNIFICANT DIGIT: Least significant digit is programmed to count by 1, 2, or 5. (see Table 1-1. Specifications).

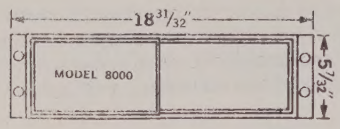
OPTION 10. PANEL MOUNTING BEZEL:



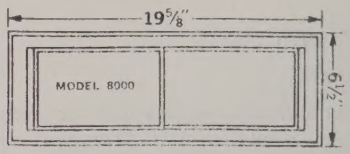
OPTION 11. PANEL MOUNTING BEZEL AND 19" PANEL:



OPTION 12: 19" RACK MOUNTING PANEL AND EARS:



OPTION 14. FULL WIDTH CASE WITH BLANK PANEL AND BEZEL:



OPTION 13. FULL WIDTH CASE WITH BLANK PANEL:

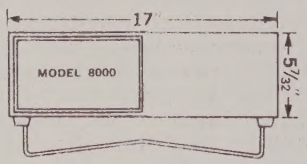


Table 1-1. 8000SW Specifications

INPUT:	±1 mV/V= ±5. 0V = 10, 000 counts, overranges to ±8. 5V = 17, 000 counts.
BRIDGE EXCITATION:	10. 00 Vdc at 350 mA, short circuit protected. 5. 0 Vdc at 200 mA can be supplied on special order (max. cable length is 500' with 15. 0 V bridge excitation).
DISPLAY:	5 active digits, polarity and optional dummy zero.
ACCURACY:	0. 02% of reading ±1 count at 115 Vac ±10% line voltage and 72° ±5°F for 30 days. Instrument linearity is ±0. 01% ±1 count.
BRIDGE LINEARIZATION: (with 4000/4500)	Parabolic correction for transducer nonlinearities of up to ±0. 25% full scale is provided to improve system accuracy to 0. 05%.
RESOLUTION:	Better than ±0. 01%
OPERATING TEMPERATURE RANGE:	+32°F to 130°F. (0°C to 54°C)
TEMPERATURE EFFECT:	On Zero ±0.001%/°F or ±0.25μV/°F, whichever is greater. On Span ±0.002%/°F
AMPLIFIER INPUT IMPEDANCE:	> 50 MΩ
AMPLIFIER EXIT CURRENT:	< 0. 5uA
COMMON MODE REJECTION:	Essentially infinite at DC (auto-zero preamplifier), 100 dB to 5k Hz.
COMMON MODE VOLTAGE LIMIT:	±8V
REMOTE SENSE IMPEDANCE:	5KΩ compensating network provides an effective remote sensing impedance of 100kΩ.

Table 1-1. 8000SW Specifications (cont'd)

ELECTRONIC DAMPING CAPABILITY:	Optional active filter.	
	Cut Off Frequency (f_c)	0. 3 Hz
	Rise Time: to 99. 9%	6. 2 sec.
	Attenuation at f_c	3 db
	Attenuation at f = 5 Hz	37 db
	Attenuation at f = 15 Hz	80 db
	Max. Rolloff	60 db/decade
	Gain	1. 0 ±0. 05% up to 0. 2 f_c
	Offset voltage	6 mV (adj. zero with trim pot)
ANALOG OUTPUTS:	0 to ±5. 0 V buffered, 2 mA, ±0. 25% accuracy.	
DIGITAL SCALING (OPTIONAL):	Digital Scaling available to provide 10, 000 counts: 10, 000 counting by 1 20, 000 counting by 2 30, 000 counting by 3 up to 90, 000 counting by 9	
LEAST SIGNIFICANT DIGIT:	Least significant digit can be programmed to count by 1, 2, or 5's, i. e. 10, 000 counts = 10, 000 counting by 1's (0. 01% resolution) 10, 000 counts = 10, 000 counting by 2's (0. 02% resolution) 10, 000 count = 10, 000 counting by 5's (0. 05% resolution).	
DISPLAY TYPE:	Numerical display neon tubes with 5/8" numerals.	
DECIMAL POINT CONTROL:	5 decimal points can be internally or externally selected.	
DISPLAY STORAGE:	Display storage (non-blinking operation) for all digits and polarity.	
DISPLAY HOLD:	Display maintains the last reading indefinitely when external command is applied.	
MEASURING SPEED:	3 readings per sec. Externally variable up to 1 reading every 2 sec.	
DIGITAL OUTPUTS (OPTIONAL):	5 BCD 1-2-4-8 digits plus single bit polarity.	
LOGIC LEVELS AND CURRENTS:	Logical "1": +2. 4 V min. Logical "0": +0. 4 V max. All digital output signals are capable of sinking 8 mA at lower logic level and sourcing 0. 2 mA at upper logic level.	
DATA READY SIGNAL:	Upper level (+2. 4V min) to lower level (+0. 4V max) transition with output returned to upper level exponentially in 12μ sec (nom).	
POWER:	115V ±10% or 230 V ± 10%, 50 to 400 Hz, 25W nominal (Single bridge-no external power) up to 50W when using max. power option.	

Table 1-1. 8000SW Specifications (cont'd)

INPUT/OUTPUT CONNECTIONS:	All input output connections are made at the rear of the instrument.
WEIGHT:	14 pounds. (6.35Kg)
DIMENSIONS:	5 1/4 x 8 1/2 x 19 5/16 inches (standard mounting). (133.35 x 216 x 480.5 mm)
EXTERNAL AVAILABLE POWER:	±15V, 60 mA +5V, 100 mA ±28Vdc (unreg.) at 150 mA (additional 350μF at 35V filter capacitor required for -28V supply).
STORAGE TEMPERATURE:	-5°F to +150°F. (-20°C to +65°C)

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information on unpacking, inspection, installation and repacking for shipment, if necessary.

2-3. INITIAL INSPECTION.

2-4. Mechanical Inspection.

2-5. If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the unit for external damage such as broken controls or connectors, and dents or scratches on the panel surface. If damage is found, refer to Paragraph 2-8 for recommended claim procedure and repacking information. If shipping carton is not damaged, check the cushioning material and note any signs of severe stress as an indication of rough handling in transit. Retain the packing material for possible future use.

2-6. Electrical Check.

2-7. Check the electrical performance of the equipment as soon as possible after receipt. The preoperational calibration check and the normal operation process should provide a valid indication of satisfactory performance.

2-8. CLAIMS AND REPACKING.

2-9. Claims for Damage.

2-10. If physical damage is evident or if the instrument does not meet specifications when received, notify the carrier and the nearest BLH Sales/Service Office (see list in back of manual). The Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

2-11. Repacking for shipment or Storage.

2-12. If the instrument is to be shipped to a BLH Sales/Service Office, or to the factory, attach a tag showing owner with address, instrument model and serial number, and the repair required. The original shipping carton and packaging material may be reusable. The BLH Sales/Service Office will also provide information and recommendations on materials to be used if the original packaging material is not available or not reusable. Materials should include, (1) a double-walled carton (check with a freight carrier for test strength required), (2) polyfoam, heavy paper, or sheets of cardboard, to protect all instrument surfaces ; use extra material around projecting parts of the instrument, (3) at least four inches of tightly-packed, shock absorbing material surrounding the instrument. Close the package securely with heavy paper tape.

2-13. INSTALLATION.

2-14. General.

2-15. Installation of each BLH Model 8000SW Indicator differs slightly depending upon the mounting configuration specified and the number of transducers in use. Power requirements, mounting information, fusing, and transducer/indicator interface information are discussed in the following paragraphs.

2-16. Location.

2-17. The instrument will operate satisfactorily between +32°F and 130°F in most environments. In system applications, however, the narrowest temperature range of a given system component should be used as the determining factor. System location should be relatively free from dust, unusual temperature extremes, high humidity and vibration. The System should not be located in areas containing explosive or corrosive vapors or in the vicinity of strong magnetic fields (e. g. , large power transmission cables, welding equipment, high voltage transformers, etc.).

2-18. Mounting.

2-19. The instrument can be bench (portable), rack, or panel mounted, depending upon the type ordered. Conversion kits are available through the BLH Sales/Service Offices listed at the rear of this manual if it becomes necessary to change the original mounting configuration.

2-20. BENCH MOUNTING. When the bench mounted instrument, Figure 2-1, is specified, the Indicator is shipped from the factory ready for use. A tilt bail is provided for ease of operation.

2-21. RACK MOUNTING. If ordered as a rack mounted instrument, Figure 2-2, the Indicator is installed in a mounting enclosure at the factory. The enclosure is shipped with universal mounting flanges attached, ready for installation in a standard 19 inch cabinet; mounting screws are packaged with the instrument.

CAUTION

Ambient temperature in rack during operation should not exceed the maximum specified. Make certain that position in rack permits ample air circulation around the instrument and that nearby instruments do not discharge hot air directly into it.

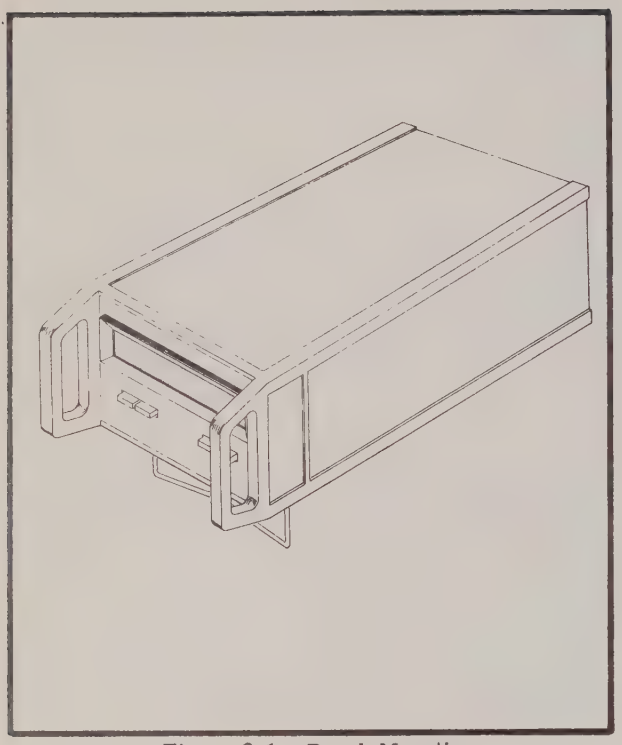


Figure 2-1. Bench Mounting

2-22. PANEL MOUNTING. The panel mounted instrument, Figure 2-3, is shipped from the factory with aluminum bezel packed separately for installation in system control panels. The instrument can be installed in a panel 1/8 to 1 inch thick after cutting an opening to the dimensions specified in Figure 2-4. See Figure 2-5 for assembly and mounting instructions.

2-23. ELECTRICAL CONNECTIONS.

2-24. General.

2-25. The two major components of a 8000SW System - Transducers, Switching Unit, and Indicator - are interfaced with multiple conductor shielded-cable. Transducers are connected directly to the rear of the Switching Unit at Terminal Boards with four-conductor transducer cable. If necessary, additional cable can be used to extend the length of the run. Extension cables are spliced at a cable extension box designed for this type of application. Four-conductor cabling from multiple transducer installations is joined at a totalizing junction box and brought to the rear of the Switching Unit with a six-conductor shielded cable. The two extra conductors are remote sensing leads. Remote sensing is discussed in detail in the Switching Unit Manual.

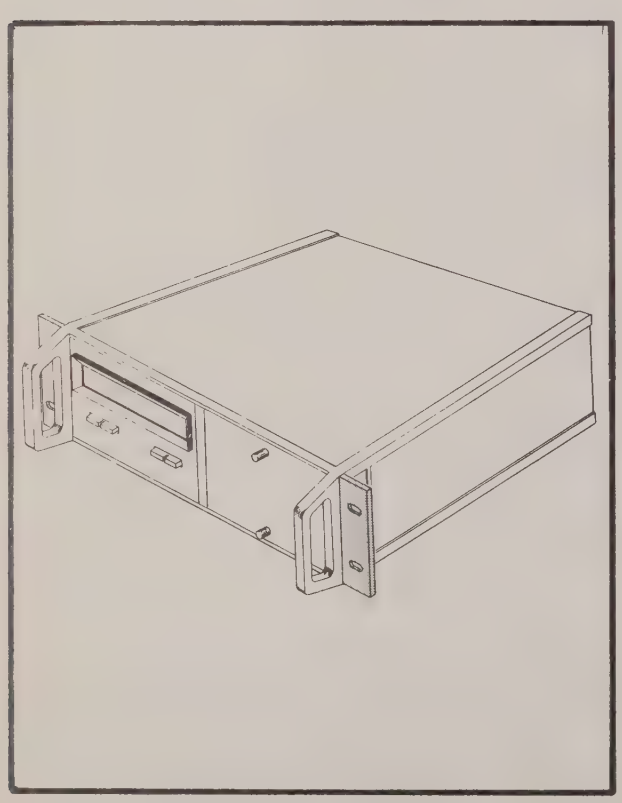


Figure 2-2. Rack Mounting

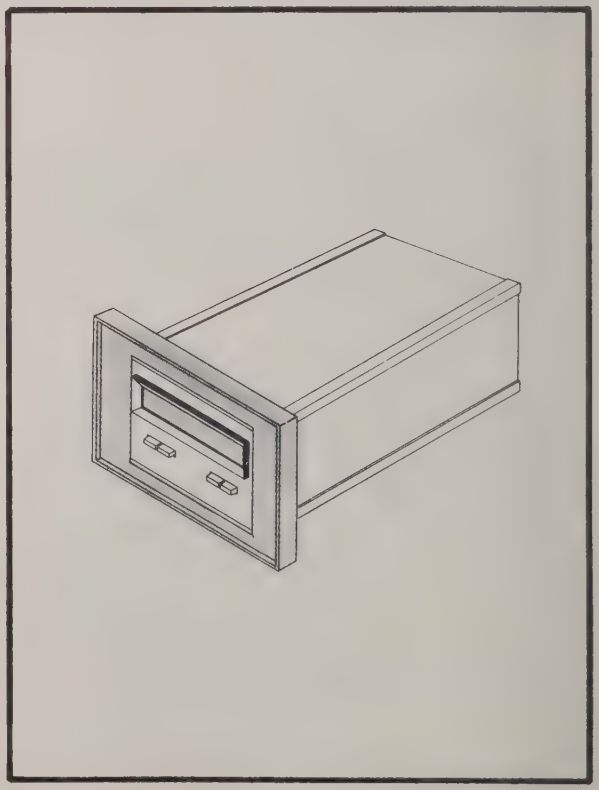


Figure 2-3. Panel Mounting

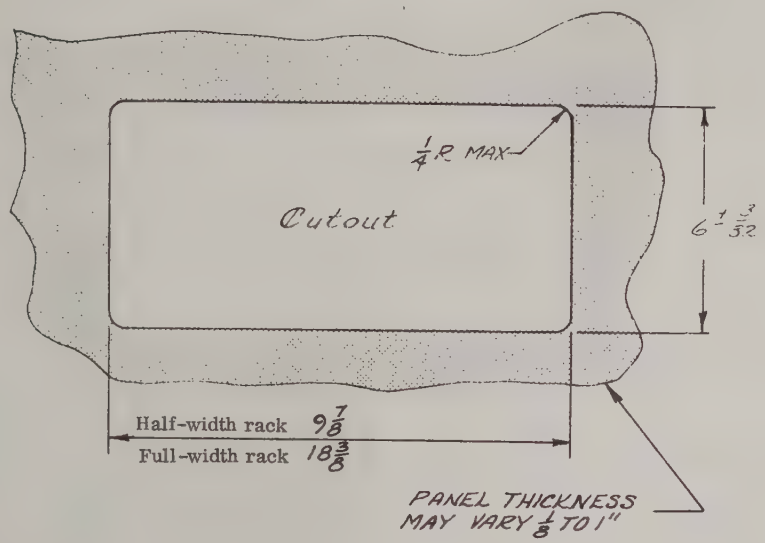
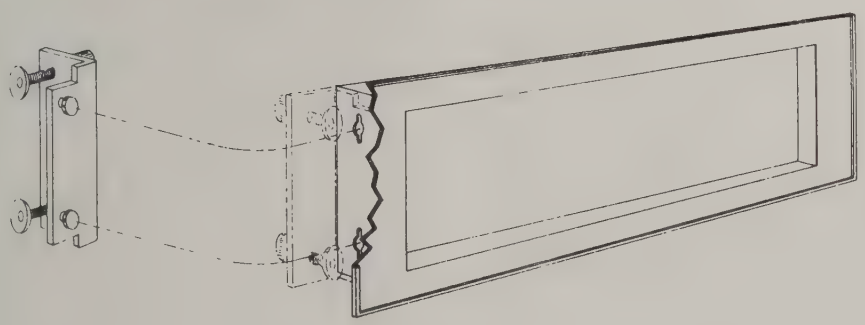


Figure 2-4. Panel Cut-Out Dimensions



1. Assemble bezel with 8 round-head screws provided with kit.
2. Unscrew 4 flat-head screws (exposed when trim strips are removed) from sides of Case assembly and remove mount plates.
3. Carefully fit bezel around front panel of instrument and secure with same screws used for mount plates.
4. Lock clamping brackets into side frames of bezel as shown above.

Figure 2-5. Bezel Assembly and Mounting Instructions

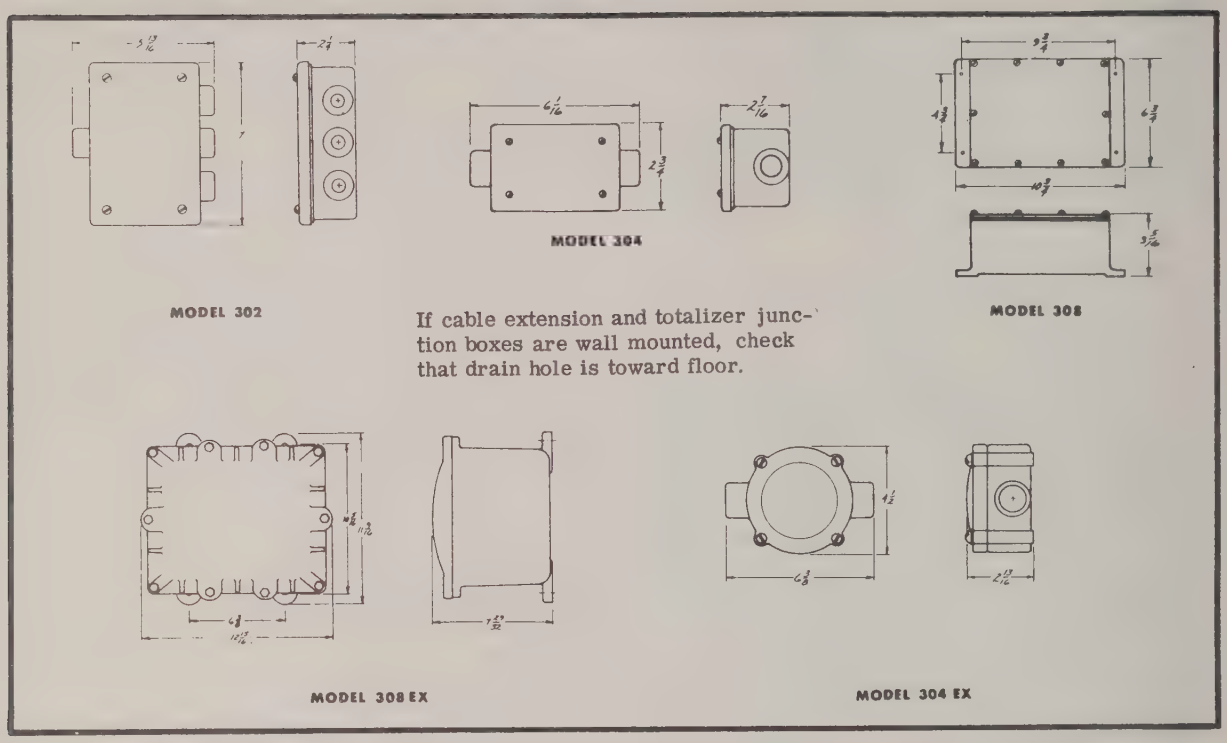

MODEL 302
MODEL 304
MODEL 308
If cable extension and totalizer junction boxes are wall mounted, check that drain hole is toward floor.
MODEL 308 EX
MODEL 304 EX

Figure 2-6. Junction Box Mounting Dimensions

2-26. The cable extension boxes and/or totalizer junction boxes, where used, should be installed within reach of the four-conductor transducer cables and, in the case of the totalizer boxes, by the six conductor cable leading to the rear of the indicator cable extension and totalizer junction boxes should be mounted where protected from excessive moisture. The boxes should be potted only after a complete check has been run on the system. All connections are made by securing transducer, instrumentation, and power cable leads to barrier-type terminal strips (connectors are optional). Existing cable leads not equipped with lugs can be soldered into place for additional security. Mounting dimensions for cable extension and totalizer junction boxes are specified in Figure 2-6.

2-27. Connector J1.

2-28. Rear panel connector J1 performs a multiple function. Pins 36, 21, 22, 23, and 20 are decimal point blanking pins. When these pins are connected to ground, the decimal point to the left of the 2nd, 3rd, 4th, 5th, and 6th digits respectively in the digital display will be blanked. Pins 13 through 18 duplicate the functions of TB1. Voltages for external control functions are available at pins 3 and 5 (±15 Vdc regulated) and at pins 30 and 31 (±28 Vdc unregulated). Pins 4 and 35 are common. A signal cutoff switch can be installed across pins 1 and 27. This switch will break analog signal at the input of the analog to digital converter allowing the analog signal to be utilized elsewhere. Analog output is also developed on pin 2 during normal instrument operation without switching. Pin 2, along with pin 6, doubles as a remote span control connection point. When the bridge linearization option is specified, pin 25 can be used as an external connection point for a remote adjustment control. The standard sampling rate (three readings per second) can be slowed to a maximum of one reading every two seconds by placing a one megohm resistor or potentiometer across terminals 19 and 37. Pins 7 through 12 are optional multiplier programming pins used to scale the digital display to a convenient figure. If the Indicator is factory calibrated to display a readout of 10,000 counts at a full scale output of 1 mV/V, for example, the instrument can be programmed by the operator to display a readout of 20,000, 30,000, 40,000 etc. at the same full scale output by varying the jumpering sequence between pins 7 through 12. The easiest and most practical place to jumper the pins is at the rear (wiring side) of the mating connector rather than at Connector J1. Figure 2-8 illustrates proper jumpering sequence for multiples of X1 through X10. Note that the illustrations are wiring side views of the mating connector (Amphenol 17-10370, BLH 137404). Mating connectors are not supplied unless specified on the sales order. Figure 2-7 identifies all functional pins.

NOTE: Above data is for information only. Refer to appropriate switching unit manual for connection data.

2-29. Connector J9.

2-30. Connector J9 is a 37 pin connector mounted on rear panel above J1. Twenty-two pins are utilized for the actual BCD output. HOLD (pin 1) and HOLD (pin 2) are normally jumpered; breaking the connections (as with a momentary pushbutton switch) stops sampling and allows the printer or other external devices to accurately record the last indicated reading. Pin 22 (data ready signal) indicates that the measurement cycle is completed and that data is ready to read. Upper level (+24V minimum) to lower level (+0.4V maximum) transition with output returned to upper level expoentially in 12μsec (nom.). Figure 2-7 identifies pin function and location. J9 mates with Connector Assembly, BLH 415258-1, not supplied unless specified.

2-31. TRANSDUCER CONNECTIONS. Connect the transducer(s) to Terminal Boards on the Switching Unit through the extension and/or totalizer boxes as directed by the Switching Unit Manual.

2-32. FINAL WIRING CHECK. After all wiring is completed, check terminations for proper soldering and tight terminal connections. Check and tighten each connector to assure full engagement and proper seating. Provide strain reliefs where necessary. The instrument is now ready for the Preoperational Calibration Check detailed in Figure 2-10. Do not pot the cable extension or totalizer boxes until this check has been made.

2-33. Power Requirements.

2-34. The standard indicator can be operated from any 115 Vac to 400Hz power source; power dissipation is 25W. (Indicators wired for operation at 230 Vac are available on special order). Check that instrument is capable of operation at desired voltage before applying power. Overcurrent protection is provided by a rear panel mounted 0.3 ampere time-delay fuse.

2-35. AC POWER CABLE. To protect operating personnel, the National Electrical Manufacturer's Association recommends that the instrument panel and cabinet be grounded. The instrument is equipped with a six-foot three-conductor power cable. The third conductor is the ground conductor, and when the instrument is plugged into an appropriate receptacle the indicator is grounded. The offset pin on the power cable three-prong plug is the ground connection. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green lead on the adapter to ground.

2-36. CONTROLS.

2-37. Controls used to operate and calibrate the instrument are listed and identified in Figure 2-9, Control Data.

2-38. CALIBRATION.

2-39. The indicator measuring circuits contain both fixed and variable high-stability, precision wire-wound resistors for long dependable service. Once adjusted, the indicator seldom requires recalibration. If, however, a component fails and is replaced, or if for other reasons, the accuracy of the indicator is in doubt, the calibration should be checked and if necessary adjusted.

2-40. CALIBRATION METHODS.

2-41. The recommended methods for calibrating the Model 8000 SW Digital Indicator are:

a. Calibration of the conditioner/readout system complete with transducers and switching unit using internal Check Cal circuit or Check Cal on the 4000/4500 Switching Unit.

b. Calibration of indicator independent of transducers using a BLH Model 625 Calibrator to simulate signal input.

c. Calibration of complete conditioner system through application of a known force to transducers. Select the method best suited to operating requirements.

2-42. CHECK CAL CIRCUIT. Refer to Figure 2-10 for detailed instructions.

2-43. CALIBRATION WITH MODEL 625 PRECISION CALIBRATOR. The Model 625 Calibrator used as a substitute signal source can be connected directly to the input terminal strip at the rear of the Switching Unit. On multiple transducer systems, the calibrator can be connected to one of the input terminal strips inside the junction box in place of any one of the transducers. This method provides greater accuracy since the cables normally used during system operation are included in the circuit.

2-44. The BLH Model 625 provides mV/V output in 5 ranges with ten equal steps per range as shown in Table 2-1. Select the range and step which provides output equivalent to the mV/V calibration of the system under test. If the exact setting is not possible, set the calibrator for output nearest but lower then desired output and calibrate accordingly. For example, for a system having a full scale calibration of 1.25 mV/V = 10,000 pounds, the nearest setting available on the Model 625 Calibrator would be 1.2 mV/V or 96% of required setting. In this case, the AMPL SPAN control would be adjusted for a readout display of 9600 pounds. Once the correct ratio of input voltage is established, the system can be expected to track accurately over its entire range.

2-45. Additional information concerning the Model 625 Calibrator is included in the instruction manual supplied with it.

Table 2-1. 625 Calibrator Output Settings

OUTPUT RANGE	GRADUATED IN
0-0.5mV/V	10 steps of 0.05mV ea
0-1mV	10 steps of 0.1mV ea
0-2mV	10 steps of 0.2mV ea
0-5mV	10 steps of 0.5mV ea
0-10 mV	10 steps of 1.0mV ea

2-46. DEAD WEIGHT CALIBRATION. The total system (transducer/instrument package) can be accurately checked and recalibrated by using the universally accepted method for calibrating weighing systems known as the dead weight method. This involves the application of a known force, generated by dead weight, to the tank, bin, hopper, scale, etc. supported by the transducers, and adjusting the AMPL SPAN control of the system until the digital display agrees with the applied force. Since standard dead weights used for this purpose are extremely accurate, very satisfactory results can be obtained where this technique is employed. Systems requiring a seal of approval from the Bureau of Weights and Measures must be calibrated with standard weights approved by the authority. Before attempting to perform a calibration check of the system, make certain that all units are functioning properly. Check and adjust the calibration as follows:

a. Press the OPER button and adjust the BRIDGE ZERO control at the front panel of the Switching Unit for zero (00000) reading. No force other than the tare load of the container should be exerted on the transducers prior to this adjustment.

b. Apply dead weight(s), equivalent to approximately 80% of system capacity, to the transducers.

c. If the readout does not display the applied weight (within system accuracy), adjust the AMPL SPAN control of the Switching Unit for correct display of weight.

d. Remove the dead weight from the transducers.

e. Wait several minutes and then check the zero reading on the indicator. If the reading is not zero (00000), readjust the BRIDGE ZERO control on the Switching Unit.

f. If a zero adjustment was required in step "e", it will be necessary to recheck the AMPL SPAN setting. Repeat steps b, c, d and e.

g. It may be necessary to repeat the procedure of applying and removing the dead weights several times before the readout indicates zero (00000) return upon the removal of this weight.

NOTE

Zero reading on the Indicator can be plus or minus several counts provided that the system accuracy is not exceeded.

2-47. After completion of the calibration check, the linearity and repeatability of the system can be tested as follows:

a. Press the OPER button and adjust the BRIDGE ZERO control for zero (00000) reading.

b. Apply dead weight to the transducers in four increments each representing 25% of full scale system capacity.

c. Record the readings displayed by the DVM at the 1/4, 1/2, 3/4 and full scale points.

d. Compare the readings taken with computed straight line performance at each point. Deviations represent nonlinearities and should not exceed linearity tolerances specified for the system.

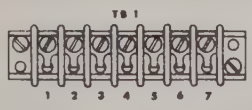
e. Test the repeatability of the system by repeating steps "a" through "d" several times. Record the readings at each test point and compare these readings with those taken at the initial linearity check. Differences in readings represent repeatability error and should not exceed specified accuracy.

2-48. HIGH CAPACITY TANK WEIGHING SYSTEM. The size and number of weights required to calibrate a high capacity tank system can be substantially reduced by using water as a substitute for all but a small portion of the required weight. For example, a tank system having a full scale capacity of 10,000 pounds can be accurately calibrated by adjusting the readout instrument to agree with an applied known force consisting of 1000 pounds (twenty 50-pound weights) of dead weight and 9000 pounds (1078 gallons approx.) of water.

2-49. The 1000 pound dead weight is placed on the tank and the resulting reading displayed is recorded. The weight is then removed from the tank and water is added until the readout displays the previously recorded reference reading. Once again, the dead weight is added to the tank and a second reference reading is recorded. Upon removal of this weight more water is added to the tank to drive the readout up to the second recorded reference point.

2-50. This process of alternately applying the dead weight, recording the reference reading, removing the weight, and adding the water to the tank until the readout displays the last recorded reference reading is continuous up to the full scale capacity of the system. At this point the AMPL SPAN control of the system is adjusted for full scale display on the readout instrument. Other capacities of dead weight and ratios of dead weight to water can be used as desired. The dead weight used for this check must be applied to and removed from the tank for the number of times it can be divided into the full scale capacity of the system.

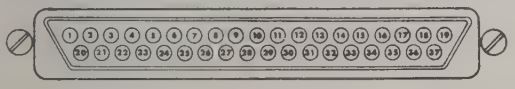
2-51. In order to reduce the number of steps required to complete the calibration, the largest available weight which can be managed at a particular installation should be used. The dead weight must be equally distributed on the tank, and attached in such a manner that it can be readily removed. It may be necessary to repeat this calibration procedure several times before satisfactory zero return is achieved.



PIN	FUNCTION	PIN	FUNCTION
1	+ 10 Vdc EXCITATION (GREEN)	5	+ SIGNAL IN (WHITE)
2	+ REMOTE SENSING (ORANGE)	6	- SIGNAL IN (RED)
3	- REMOTE SENSING (BLUE)	7	GROUND (YELLOW)
4	- 10Vdc EXCITATION (BLACK)		

1	ANALOG OUTPUT	21	DECIMAL POINT BLANKING PIN (THIRD DIGIT)
2	REMOTE SPAN CONTROL	22	DECIMAL POINT BLANKING PIN (FOURTH DIGIT)
3	+ 15V	23	DECIMAL POINT BLANKING PIN (FIFTH DIGIT)
4	COMMON (AC SIGNAL)	24	FULL SCALE COUNT OUT
5	- 15V	25	TRANSDUCER NONLINEARITY ADJ.
6	REMOTE SPAN CONTROL	26	UNFILTERED OUTPUT
7	MULTIPLIER PROGRAMMING PIN*	27	REMOTE SIGNAL CONTROL – FILTER OUTPUT
8	MULTIPLIER PROGRAMMING PIN*	28	REMOTE LINEARITY ADJ. (-)
9	MULTIPLIER PROGRAMMING PIN*	29	INHIBIT (DATA HOLD)
10	MULTIPLIER PROGRAMMING PIN*, + 5V	30	- 28V (UNREG.)
11	MULTIPLIER PROGRAMMING PIN*	31	+ 28V (UNREG.)
12	MULTIPLIER PROGRAMMING PIN*	32	REMOTE PRINT COMMAND
13	+ EXCITATION	33	REMOTE FILTER INPUT
14	- EXCITATION	34	COMMON — DC SIGNAL
15	- SIGNAL IN	35	COMMON — DC SIGNAL
16	+ SIGNAL IN	36	DECIMAL POINT BLANKING PIN (SECOND DIGIT)
17	- REMOTE SENSING	37	SAMPLE RATE CONTROL
18	+ REMOTE SENSING		
19	SAMPLE RATE CONTROL POTENTIOMETER		
20	DECIMAL POINT BLANKING PIN (SIXTH DIGIT)		

*Optional: may not be used.



J9

5	BCD OUT (FIRST DIGIT) 1 (MSD)	17	BCD OUT (THIRD DIGIT) 4
6	BCD OUT (FIRST DIGIT) 2	18	BCD OUT (THIRD DIGIT) 8
7	BCD OUT (FIRST DIGIT) 4	19	BCD OUT (FOURTH DIGIT) 1
8	BCD OUT (FIRST DIGIT) 8	20	BCD OUT (FOURTH DIGIT) 2
9	BCD OUT (SECOND DIGIT) 1	24	BCD OUT (FOURTH DIGIT) 4
12	BCD OUT (SECOND DIGIT) 2	25	BCD OUT (FOURTH DIGIT) 8
13	BCD OUT (SECOND DIGIT) 4	26	BCD OUT (FIFTH DIGIT) 1 (LSD)
14	BCD OUT (SECOND DIGIT) 8	27	BCD OUT (FIFTH DIGIT) 2
15	BCD OUT (THIRD DIGIT) 1	28	BCD OUT (FIFTH DIGIT) 4
16	BCD OUT (THIRD DIGIT) 2	29	BCD OUT (FIFTH DIGIT) 8
		3	BCD POLARITY BIT (+)

4	BCD POLARITY BIT (-)
1	REMOTE PRINT COMMAND
2	COMMON (B)
22	DATA READY
31	COMMON (A)
21	+ 5V
30	RESET
32	COUNT OUT
34	END UP INTEGRATE
35	INHIBIT(DATA HOLD)
36	+15V
37	-15V
33	OFFSET

Figure 2-7. Rear Panel Connection Data

Note: Pin 7 is ground. Pin 10 is +5V.

Multiply Readout X1
(No Jumpers)

Multiply Readout X2
Jumper 8, 9, 10, & 11
Jumper 7-12

Multiply Readout X3
Jumper 8, 9, & 10
Jumper 7, 11, & 12

Multiply Readout X4
Jumper 8-10
Jumper 7, 9, 11, & 12

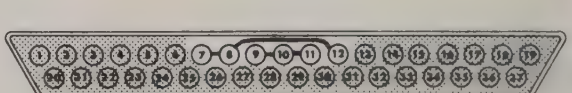
Multiply Readout X5
Jumper 7, 8, 9, & 11
Jumper 10 and 12

Multiply Readout X6
Jumper 7, 8, 9, & 12
Jumper 10-11

Multiply Readout X7
Jumper 7, 8, 11, & 12
Jumper 9-10

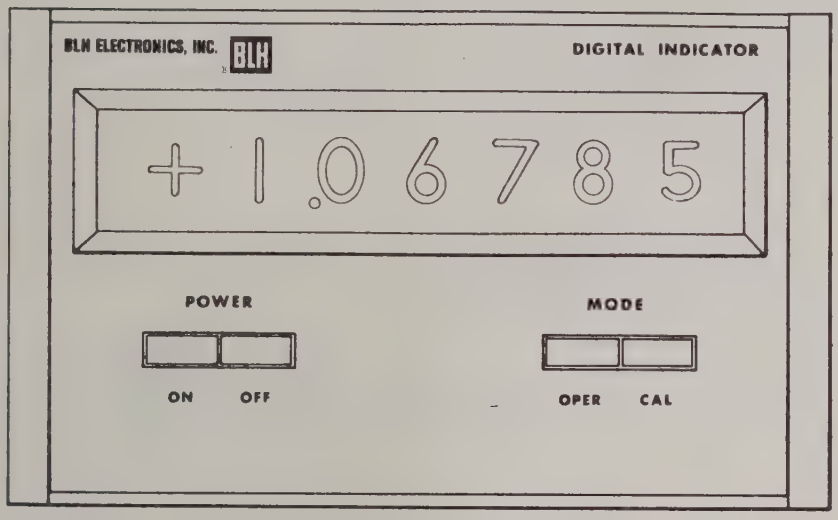
Multiply Readout X8
Jumper 7, 9, & 11
Jumper 8, 10 & 12

Multiply Readout X9
Jumper 7, 8, & 9
Jumper 10, 11, & 12



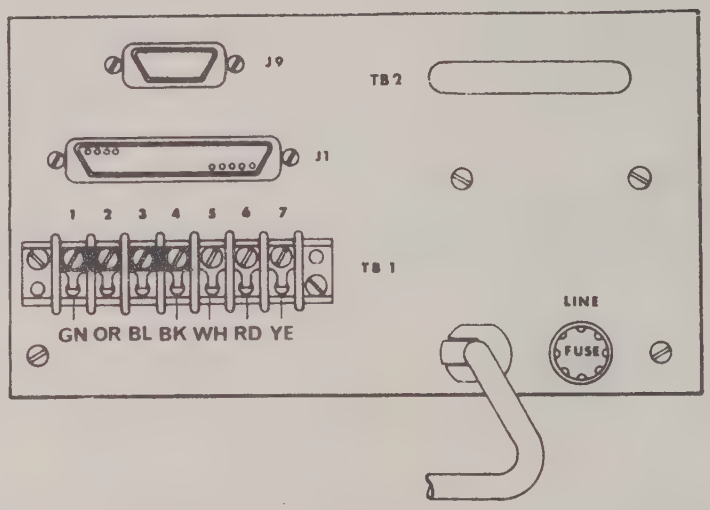
Multiply Readout X10
Jumper 7, 8, & 12
Jumper 9, 10, & 11

Figure 2-8. Multiplier Jumper Placement, Rear (wiring side) View Of Mating Connector



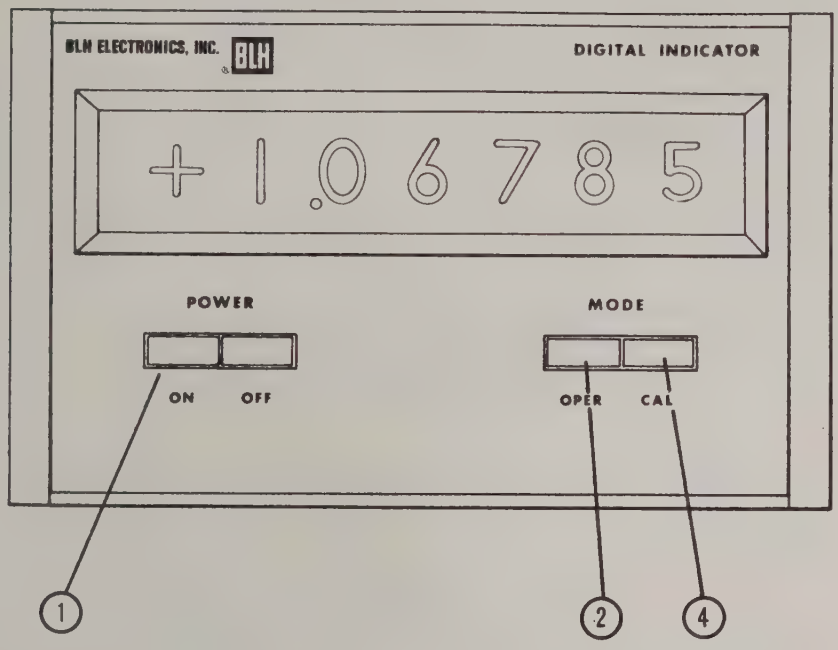
1. DIGITAL DISPLAY. 5/8 inch neon numerals. Five active digits with optional polarity and dummy zero tubes.
2. POWER ON/OFF. Applies line power (105-125Vac, 50-400Hz at approximately 25 watts) to the instrument.
3. CAL MODE. Push-button switch. Impresses a precise calibration signal across the input of the Indicator for calibration purposes. Not used with the 4000/4500 Switching Unit.
4. OPER MODE. Push-button switch. When pressed, disconnects instrument from the calibration mode and places instrument in normal operating mode.

Figure 2-9. Control Data



1. TB-1. Transducer excitation and signal input terminal board. (See Figure 2-7 for terminal function.) Typically not used with Switching Units.
2. CONNECTOR J1. Thirty-seven pin connector. Provides connection points for decimal point blanking function, external sample rate control and multiplier programming. (see Figure 2-7 for pin function.)
3. POWER CORD. Three-conductor power cord for primary line voltage input.
4. LINE FUSE. 0.3 ampere 230V time delay fuse (Slo-Blo).
5. CONNECTOR J9. BCD output connector; provides connection points for BCD output function (optional, may not be present).
6. TB-2. Optional connector location for backset control functions, etc. Not supplied with standard unit.

Figure 2-9. Control Data (cont'd)



IMPORTANT: Transducers must be installed and Weigh Tank or Vessel must be empty during this check.

1. Press POWER switch ON.
2. Press OPER switch.
3. Adjust BRIDGE ZERO on switching unit for 000000 indication.
4. Press CAL switch; record reading, exactly as it appears in the digital display, in the box below. When 4000/4500 Switching Unit is used, refer to that instruction manual.

CHECK CAL FIGURE

5. Subsequent calibration checks are made as follows:
   a. Return system to original, unloaded, condition..
   b. Repeat steps 1 through 3 above.
   c. Press CAL switch; if Indicator does not repeat the original reading recorded above, adjust with the AMPL SPAN control on the Switching Unit.
   d. Press the OPER switch; indicator should return to 000000. If not, adjust with the BRIDGE ZERO control on the Switching Unit.
   e. Continue this test procedure, alternately checking and adjusting the BRIDGE ZERO and AMPL SPAN settings until the check cal figure and 000000 are obtained without further adjustment.

Figure 2-10. Preoperational Check

2-52. DECIMAL POINT PROGRAMMING.

2-53. In those instruments where decimal point programming is not specified, (ref. paragraph 2-28) decimal point placement in the digital display is programmed inside the instrument at J8, the 44-pin digital display board connector. To gain access to J8, disconnect instrument power and remove the top cover of the instrument. In most instruments, the top cover is removed by simply sliding it to the rear. If the cover does not slide easily, work a narrow bladed screwdriver between the rounded lip at the rear of the cover and the side frame of the instrument as shown in Figure 2-11. Pry rearward gently until the cover moves approximately 1/4 inch. Repeat procedure on opposite side. Alternate from side to side until friction is broken and cover slides easily. Locate J8 (see Figure 2-13). Carefully work the connector off the rear edge of the digital display board. Turn the connector wiring side up and refer to Figure 2-

2-54. Unwanted decimal points are blanked in the decimal display by jumpering pins 4, D, 9, K, or T to the ground pins 12 or 16. If a pin is not connected to ground, the decimal point in the controlled tube (see chart) will remain lit. To illustrate, assume that the decimal point to remain lighted is the one just to the left of the second most significant digit. This decimal point is identified as DP3 on the chart, Figure 2-12. All other decimal points are to be blanked, (see Figure 2-14).

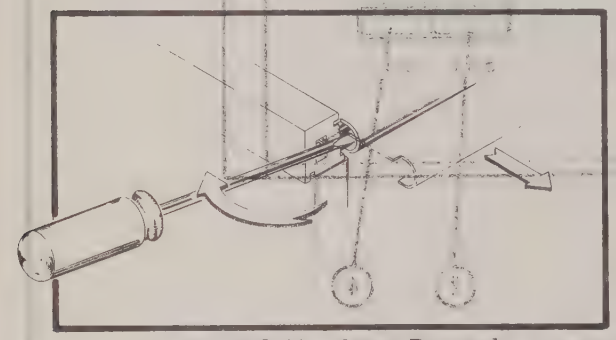


Figure 2-11. Cover Removal

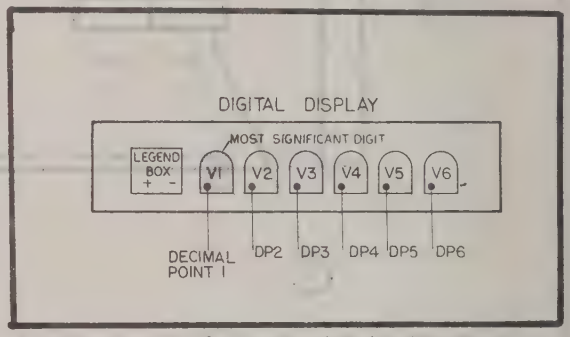


Figure 2-12. Decimal Point Location

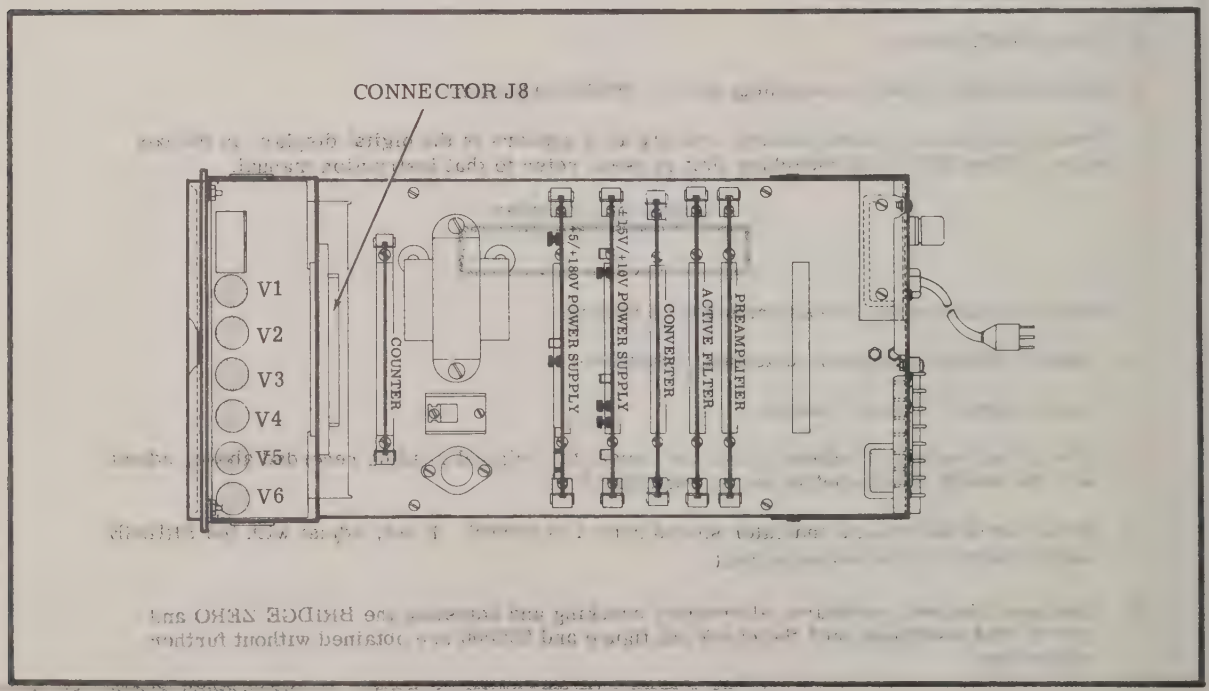
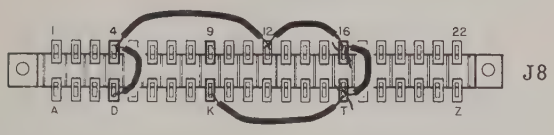


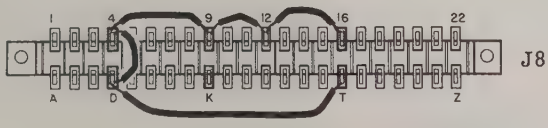
Figure 2-13. Connector J8 Location



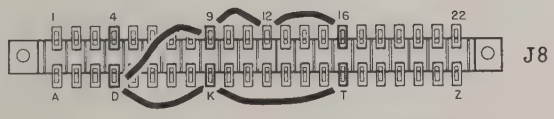
BLANKS ALL BUT DP3

Jumper pins 4, D, K, and T to ground pin 16 as shown (12 and 16 are connected at the factory). The procedure is similar for all other pins; proper jumpering sequence is illustrated below.

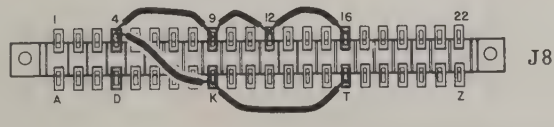
BLANKS ALL BUT DP2



BLANKS ALL BUT DP4



BLANKS ALL BUT DP5



BLANKS ALL BUT DP6

Figure 2-14. Decimal Point Blanking

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SECTION III
OPERATION

3-1. GENERAL.

3-2. Illustrations of the control panel are used to describe the sequential operation of the system. The circled numerals on the controls are keyed to the step, or steps, in which the control is used. The operating procedure detailed in Figure 3-2 assumes that all connections and initial adjustments have been made as part of the installation (preceding section).

3-3. PREVENTIVE MAINTENANCE.

3-4. Cleaning.

3-5. BLH Model 8000SW Indicators are enclosed in a vinyl coated aluminum cabinet and should be cleaned only with a damp cloth moistened in a solution of warm water and a mild detergent. Do not use any chemical solvents or abrasive cleaners on the vinyl case or anodized aluminum surfaces. Use a soft camel hair brush to remove external dust accumulation. Loose dust within the chassis can be removed with dry, low-pressure, compressed air or a small vacuum cleaner during the periodic maintenance check. Clean all mating connectors before reassembling the instrument.

3-6. Periodic Check.

3-7. BLH recommends that the instrument be performance tested by performing the calibration check before operation and at periodic intervals thereafter. The instrument can be returned to BLH for a thorough overhaul whenever necessary and checked with test instruments traceable to the National Bureau of Standards. If user maintenance and calibration is not feasible, or if unusual problems or applications are encountered, a visit by a BLH Field Service Engineer can be arranged through any of the BLH Sales/Service Offices listed at the rear of this manual.

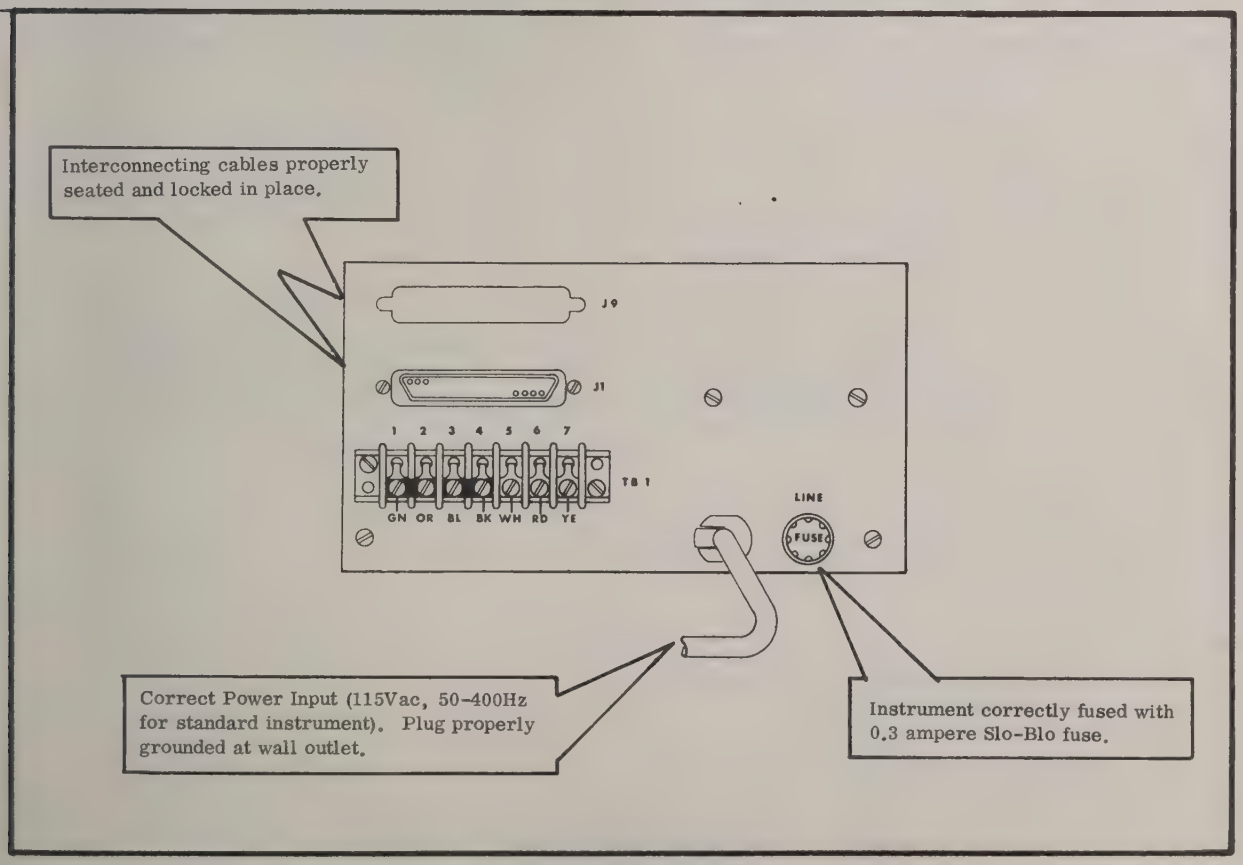
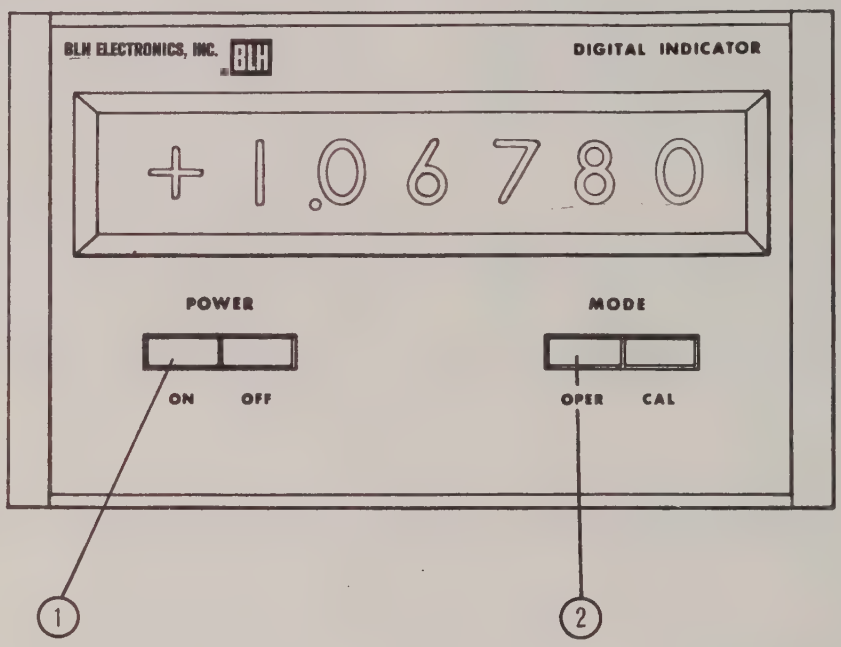

Interconnecting cables properly seated and locked in place.
J0
J1
1 2 3 4 5 6 7
TB 1
GN OR BL BK WH RD YE
LINE
FUSE
Correct Power Input (115Vac, 50-400Hz for standard instrument). Plug properly grounded at wall outlet.
Instrument correctly fused with 0.3 ampere Slo-Blo fuse.

Figure 3-1. Preoperational Connector Check



1. Press POWER switch to ON.
2. Press OPER MODE switch.
3. With no load applied to the transducer, adjust the BRIDGE ZERO control on the Switching and Balancing Unit until the digital display indicates 000000.
4. Apply load to the transducers; output will appear in the digital display.

Figure 3-2. Operation

SECTION IV
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. General.

4-3. The 8000SW measurement technique is a sampling function coupled with dual slope integration. Dual slope integration is a two step process. In the first step, the unknown input from the preamplifier is fed through an operational amplifier to an integrating capacitor. The output of this integrator is an increasing voltage with a slope proportional to the input. Integration time is controlled by counting 10,000 counts from a clock oscillator. In the second step, the integrator output is driven back to zero. The slope of the decreasing voltage is constant; therefore the time is proportional to the unknown input. This time is measured by counting pulses from a clock oscillator; the count is converted to BCD, stored, and finally displayed as a decimal digital readout.

4-4. The same integrating components and clock oscillator are used in both steps. Any shift in component values caused by temperature drift or aging is self-cancelling. The second step is a direct comparison to the internal reference voltage ensuring long term stability. The basic concept of dual slope integration is discussed in greater detail in the paragraph dealing with the analog to digital converter circuit.

4-6. DIAGRAMS. The Block Diagram, Figure 4-1, illustrates general electrical arrangement of signal and power supply circuits and direction of signal path. Refer to the Functional Diagram, Figure 4-2, before and during the circuit analysis. In addition to the diagrams described above, each circuit is illustrated in detail for comparison with the functional diagram.

4-7. DESCRIPTION. In the following paragraphs, input circuitry is discussed on the functional diagram level. Operation of the signal circuit is largely dependent upon the timed opening and closing of FET (Field Effect Transistor) switches along the signal path. In the functional diagram these switches are sequentially designated S1, S2, S3, etc. to describe overall circuit functioning. Each of these components has a corresponding circuit diagram designation e. g. S1 is the functional diagram symbol for the FET switch designated Q9 in the detailed circuit diagram of the preamplifier, Figure 4-3. The corresponding switch designations are so indicated when first discussed.

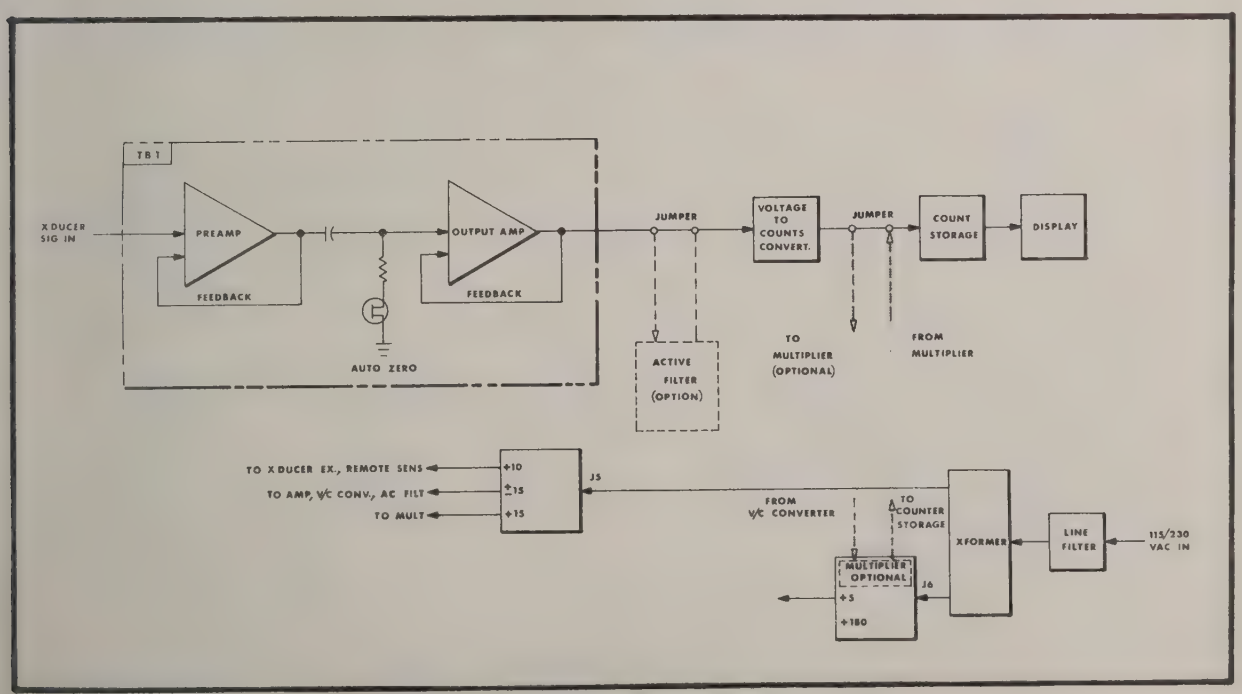


Figure 4-1. 8000SW Block Diagram

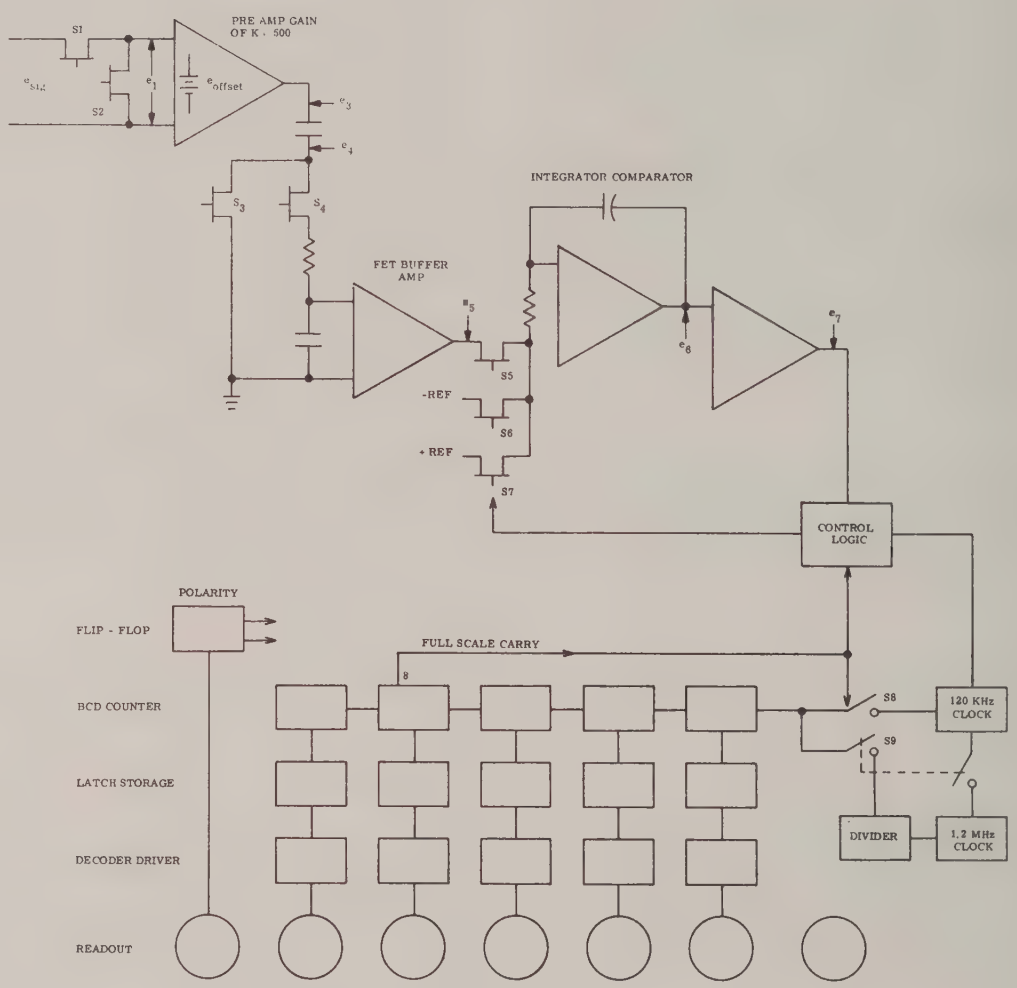


Figure 4-2. Functional Diagram

4-8. SIGNAL CIRCUIT ANALYSIS.

4-9. Input Circuitry.

4-10. The 8000SW is designed to operate with up to eight 350 ohm or four 120 ohm full bridge transducers. Bridge excitation voltage generated by the instrument is 10.00 Vdc at 350 mA maximum. In BLH transducers, strain gages are bonded to load sensing elements. Strain gages consist of a grid of fine wire or an etched foil pattern sealed between sheets of paper or plastic film. Constant excitation voltage (10 Vdc) is applied across opposite corners of the bridge so that a change in force on the transducers, stretching or compressing the gages and changing the resistance, will produce a change in output voltage. This output voltage is the signal input to the indicator.

4-11. Preamplifier.

4-12. The preamplifier (see Schematic, Figure 4-3) conditions the input signal from the transducer for presentation to the A to D converter. An integral part of the preamplifier is the auto-zero circuit which senses and eliminates drift induced offset voltages in the preamplifier.

4-13. Input signals from the signal source (transducer) are applied to the bases of Q1A/B through filter chokes L1 and L2 at pins 22 and 20, respectively. The junction field-effect transistors (JFET) Q8, Q9 are opened and closed by the sampling rate multivibrator Q5, Q6. The outputs from Q1A/B are direct-coupled to the second state Q3, Q4, which are operated as emitter-followers with the outputs fed to the operational amplifier, integrated circuit IC1.

4-14. Q2 is a constant-current source for Q1A/B referenced to Zener CR4. The output from IC1 is coupled through C7 and Q10 to the buffer amplifier with the input signal at one gate and a feedback signal at the other gate. The outputs from Q11 drive the integrated circuit IC2. The combination Q11 and IC2 is equivalent to an emitter-follower but with much higher impedance to minimize signal losses. A portion of the output signal is fed to the AMPL SPAN control in the feedback circuit to Q11.

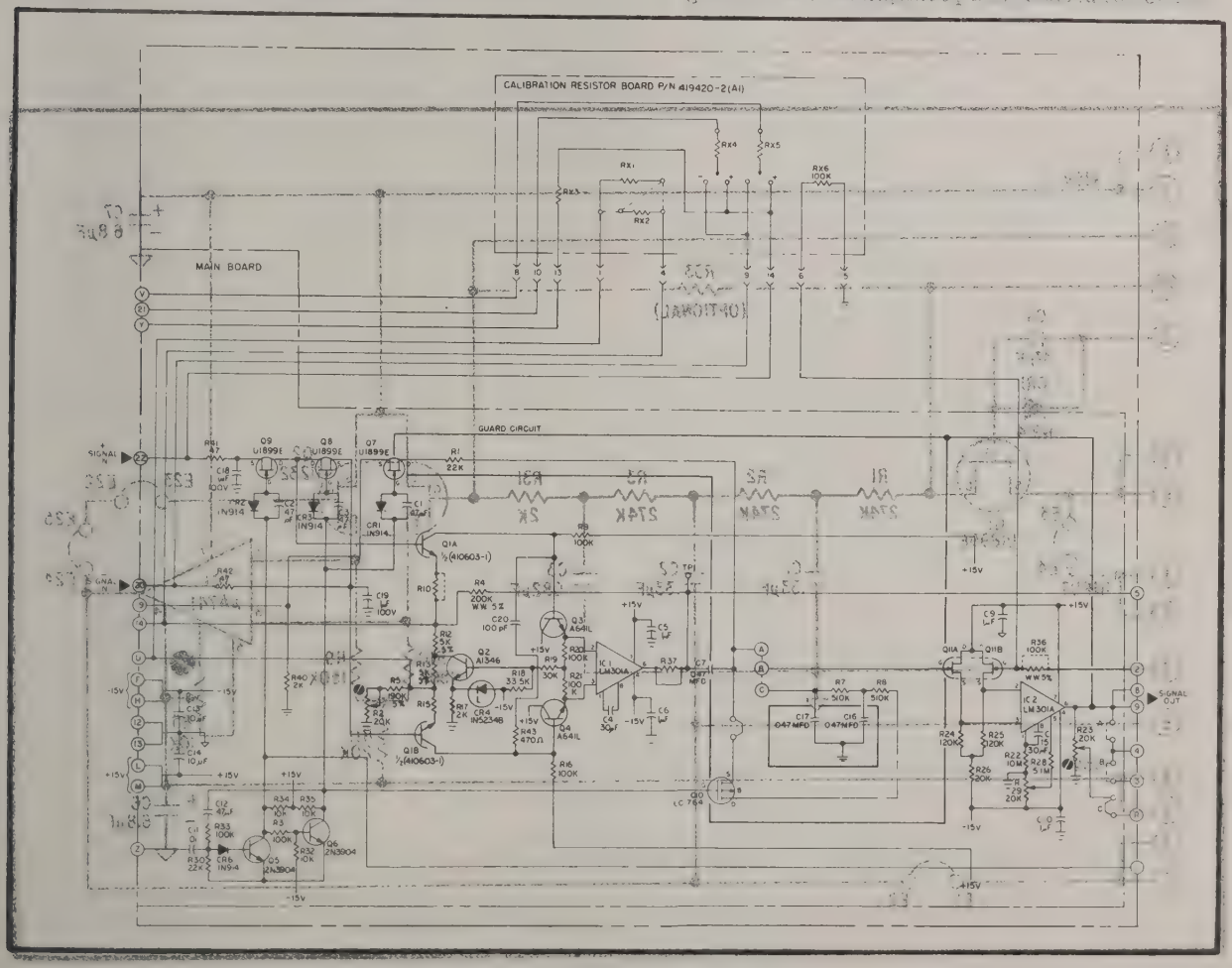


Figure 4-3. Preamplifier Circuit

4-15. The automatic zero function is controlled by the monostable multivibrator Q5, Q6. The multivibrator delivers a ±15 volt potential to the gates of Q7, Q8, Q9, and Q10 three times per second when triggered by the digital pulse from the counter circuit, located on the +5/180V Power Supply Board. The pulse is coupled into the multivibrator at pin Z. When a negative voltage is applied to the gate of Q9, Q9 opens, interrupting the input signal. Simultaneously, Q8 closes, shorting the inputs to Q1A/B; Q7 closes tieing C7 to ground; Q10 opens to hold the charge on C16 and C17. This prevents a spurious waveform from C7 being fed into the output circuits. C7 is allowed to charge to the level of any existing offset voltage present in the amplifier.

4-16. At the beginning of the next sample time, when the control multivibrator reverses the state of Q7, Q8, Q9, Q10, the stored offset voltage eliminates (bucks out) the offset voltage portion of the signal. Q10 is not present in a preamplifier that is being used with the optional active filter since the filter will be insensitive to the square wave pulse generated by C7 when Q7 closes.

4-17. Active Filter.

4-18. When used, the active filter, Figure 4-5, eliminates undesirable signal from low-level pulsating or cyclic loads on the transducers before signal reaches the converter. This system utilizes a three-pole active filter. Q1 is a series junction FET, the gate of which is driven by the one-shot and accelerated by CR1 and C5. Q1 holds and maintains the signal input voltage which is further filtered by a conventional R-C network and applied to Q2, a dual FET. Q2 is similar to and performs the same function as Q11 in the preamplifier circuit. Constant closed loop feedback is provided by IC1, an operational amplifier. IC1 also acts to restore the signal level originally presented to the input of the device, compensating for small signal losses incurred during filtration. Zero trim control R5 is factory set to maintain zero output of the filter with zero input signal.

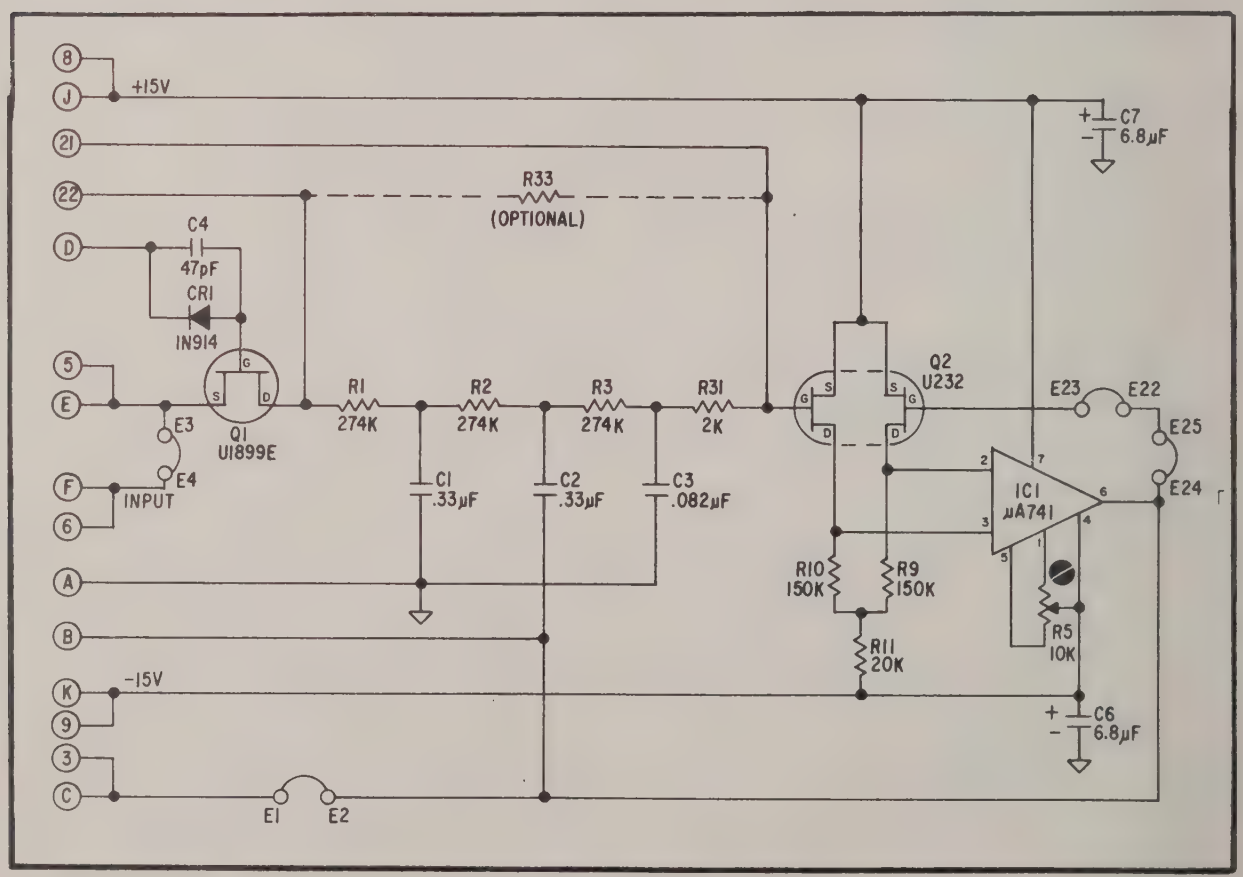


Figure 4-4. Active Filter Circuit

4-16. Analog to Digital Converter.

4-17. The analog to digital converter is an integrating voltage-to-proportional-count device that provides an output pulse train. The number of pulses (counts) contained in the output train is an exact function of the unknown input signal voltage. The count output is gated to the input of the counter and latch circuit, the output of which is a parallel digital code. In addition to the count output, the converter also provides a reset command to the counter and latch and accepts a full scale count carry signal from the counter. Figure 4-5 illustrates, in pictorial form, operation of the converter. Figure 4-6 is a detailed schematic of the device.

4-18. Upon command from the unijunction trigger circuit the counter is reset, S5 closes and the pulse train output from the internal clock is gated to the counter and latch circuit at the same time that integration of the unknown voltage is begun. The integrator is allowed to charge for a fixed time of 10,000 counts, filling the counter. The slope angle of integration is controlled by the magnitude of the unknown signal input voltage; the greater the voltage, the steeper the slope. When integration time is completed the full scale count carry signal is returned from the counter, switch S5 opens and a reference voltage having a polarity opposite to that of the stored integrator voltage is applied to the integrator. Application of the reference voltage discharges the integrator toward the baseline; direction

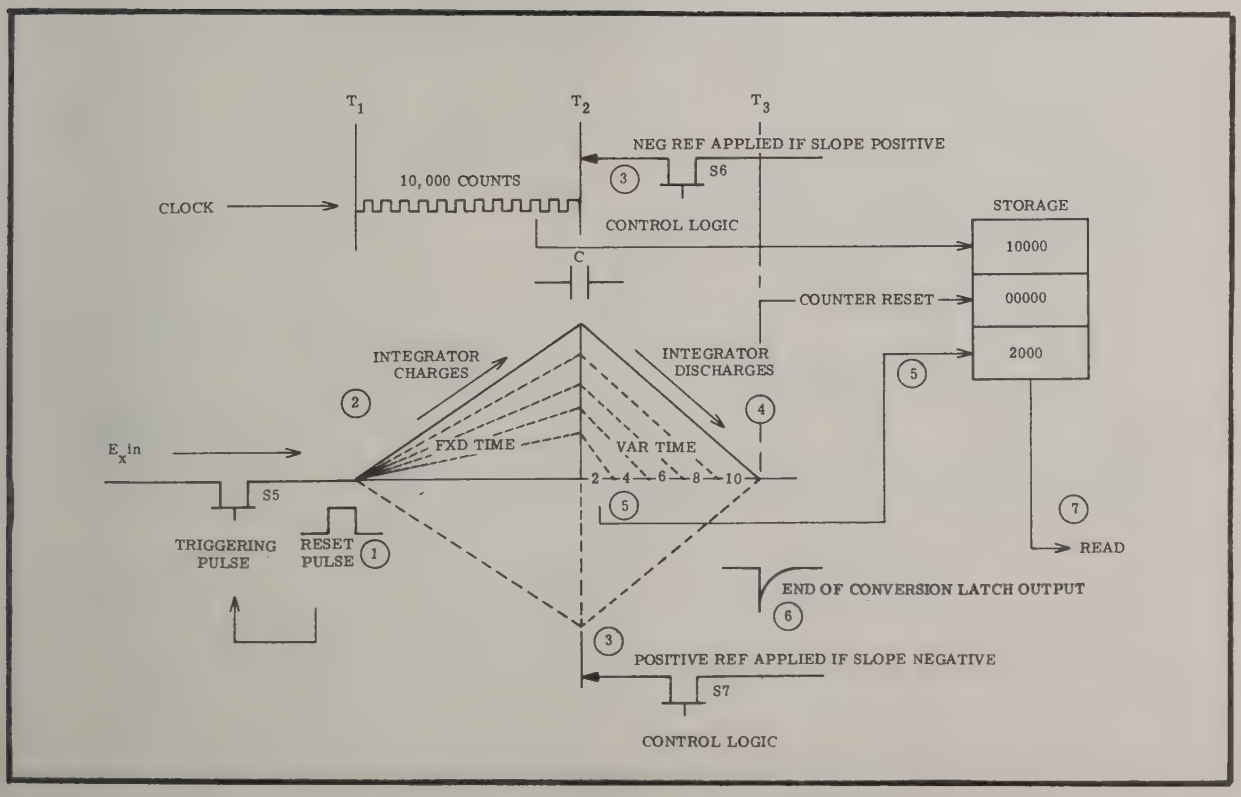


Figure 4-5. Pictorial, Dual Slope Integration

of discharge (up or down) is determined by the control logic. Because integration rate of the reference voltage is a constant, the digital number (result count) remaining in the counter is directly proportional to the unknown input signal voltage. The time required for reference integration is variable (depending upon magnitude) and is equal to:

$$\text{(input integration time)} \times \frac{\text{analog input voltage, Ex}}{\text{full scale input voltage}}$$

For example: Full scale signal input voltage is 5V.

If only half of full scale input is applied to the device.

$$\frac{10,000 \times 2.5V}{5V} = 5,000$$

The digital readout will indicate 5,000 counts. This variable integration time is, in effect, displayed as the digital readout.

4-19. All data is present in the counter until the next trigger command which resets the counter to zero for the beginning of a new conversion.

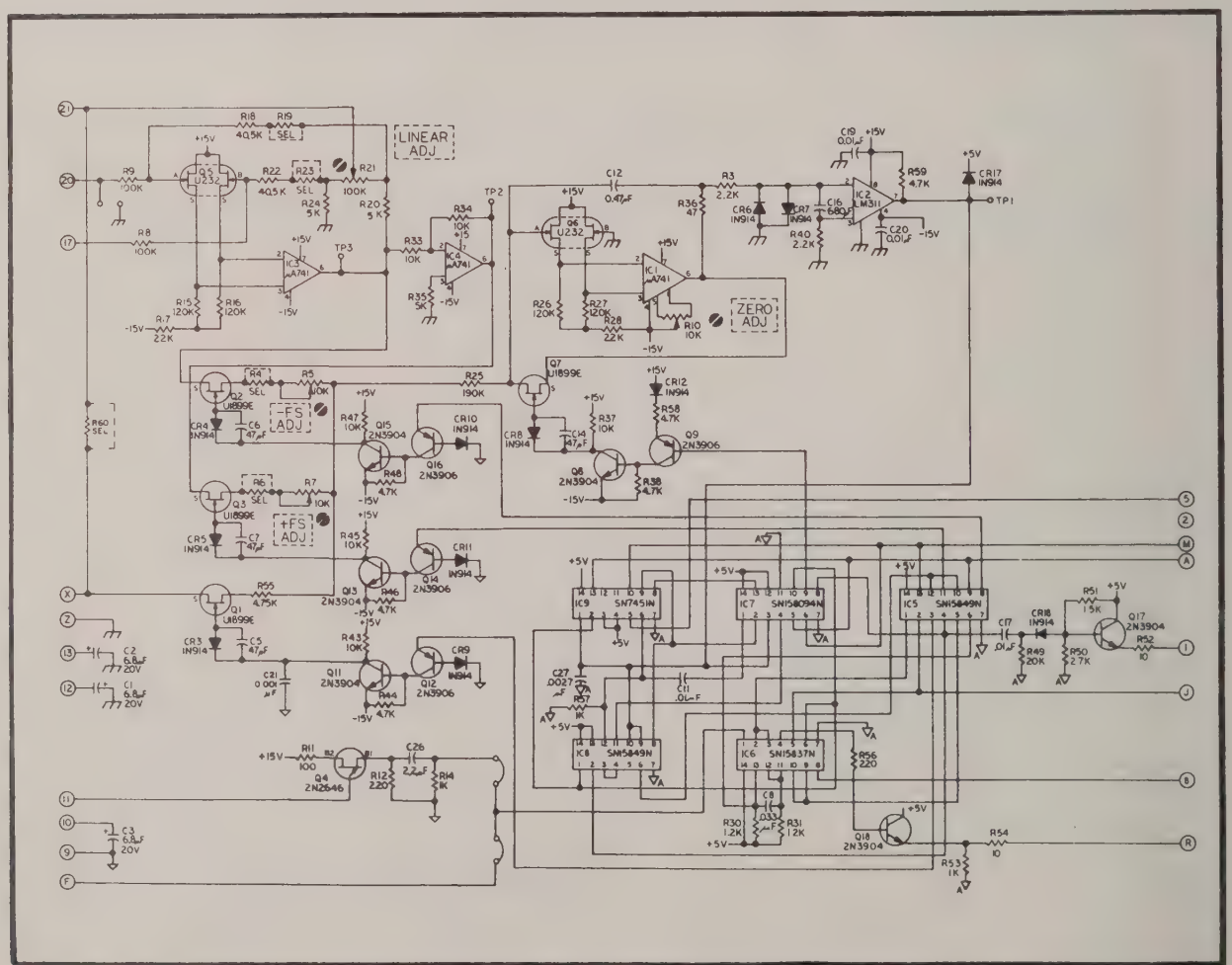


Figure 4-6. Converter Circuit

4-20. Counter and Latch.

4-21. The counter, Figure 4-7, is composed of five identical decades. Each decade is made up of an 8-4-2-1 BCD counter and a gated latch storage unit. The counter accepts pulses from the converter and divides the frequency by 10. Output from the 8 bit is fed to the next decade; all four bits are fed to the storage unit. At the end of encoding, the four bits in the counter are transferred into the flip-flops in the storage unit which ignore any changes in the state of the counter until the next end of conversion pulse.

4-22. Digital Display.

4-23. Latch unit outputs are converted to the inputs of the decoder drivers in the display circuit. The decoder drivers contain internal logic which convert the binary input into one-out-of-ten information. Output is in the form of ten high-voltage driver lines which are connected to the ten cathodes of the side reading digital display tubes, (V1, V2, etc.) See Figure 4-8.

4-24. POWER CIRCUIT ANALYSIS.

4-25. Line Filter/Transformer.

4-26. Either 115 or 230-volt ac power is connected through Fuse F1 (0.3 amp. slo-blo) and the line filter which is composed of chokes L1 and L2 and capacitor C1 to the primary of power transformer T1. T1 is connected to the inputs of both the +5/+180V and the ±15/+10V power supply circuits. The primaries of T1 are internally connected, as specified by the sales order, in parallel for 115-volt operation or in series for 230-volt operation.

4-27. +5/+180V Power Supply.

4-28. Voltage developed on the secondary windings (pins 10 and 11) of T1 is applied to a half-wave rectifier DB2 at pins D and E of the+5/+180 board, Figure 4-9. The rectified voltage is regulated at IC1, a positive voltage regulator used with a external pass transistor greatly increases current output capacity of IC1 and makes available, in addition to internal demands, an external power output of +5V at 100 mA.

4-29. Transformer output voltage is also applied to a full bridge rectifier DB1 at pins A and 1. The output of DB1 is filtered at C1 and R2 and produces +180V unregulated at pin B. Pin 2 is 180V common. The +5V regulated output is delivered to the converter, counter and latch, and the digital display boards for various power and control functions. The +180 unregulated voltage powers the neon digital display tubes and legend assembly.

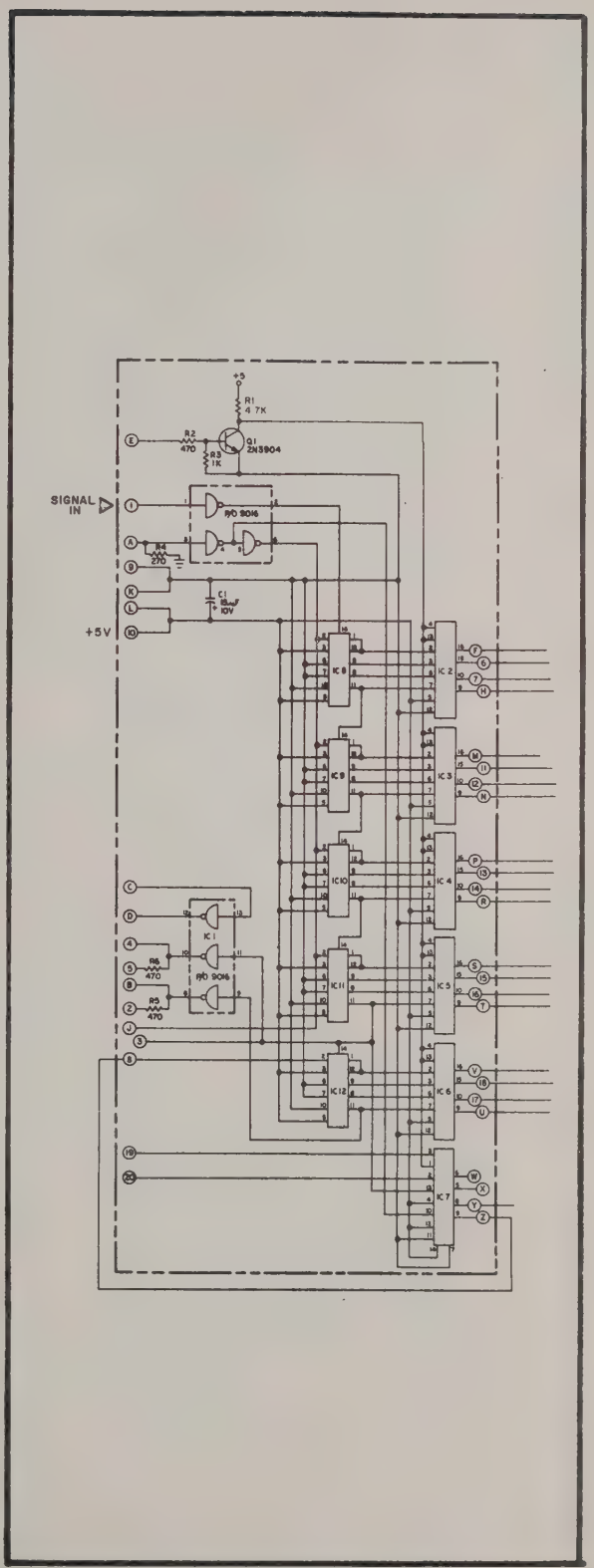


Figure 4-7. Counter and Latch Circuit

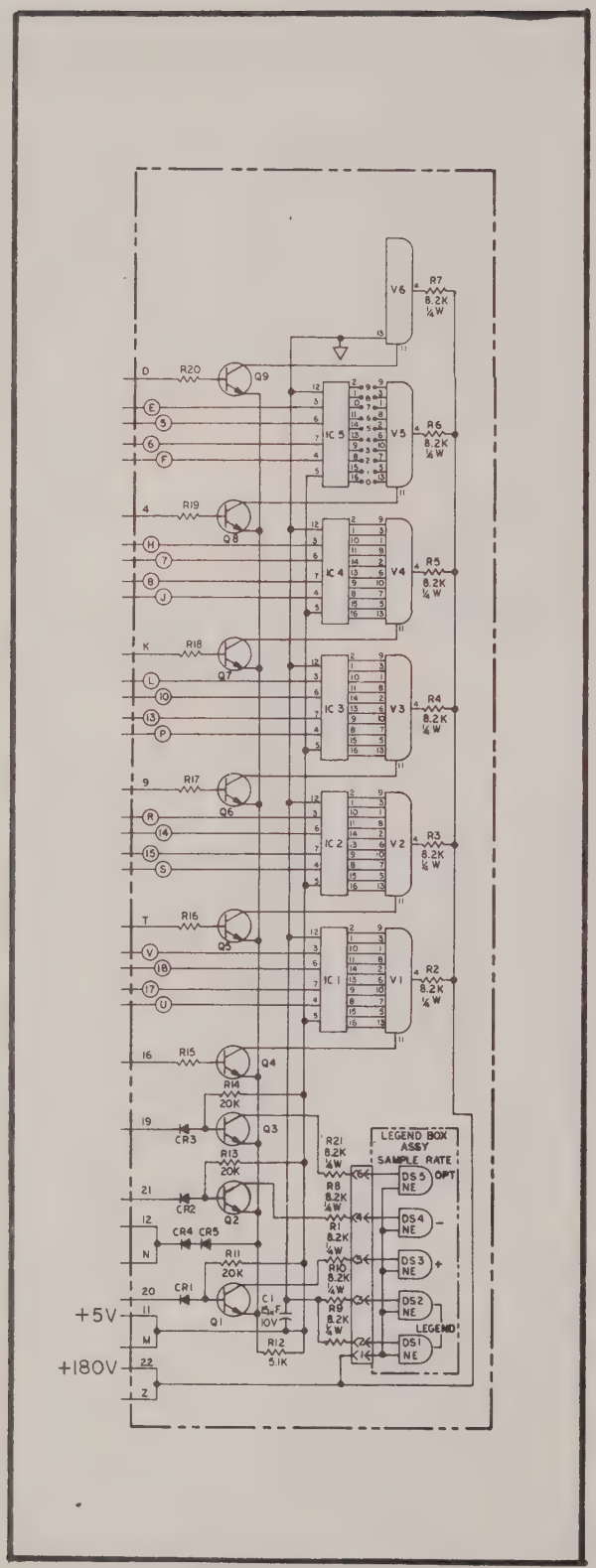


Figure 4-8. Digital Display Circuit

4-30. ±15/+10V Power Supply.

4-31. T1 also supplies voltage to the ±15/+10V supply at pins E and F. This voltage is applied to the full bridge rectifier DB1, filtered by C1 and C2, and distributed to the precision voltage regulators, ICs 1, 2, and 3. IC1 is wired as a negative voltage regulator and produces -15 volts, regulated, at pins C and D of the board. This voltage is supplied to the analog to digital converter, the preamplifier, and the active filter. IC2 is a positive voltage regulator with an external NPN pass transistor, Q1, for increased current output. The +15V is utilized by the converter, the preamplifier, and the active filter, IC3 is very similar to IC2 but connected to produce +10V regulated, the transducer excitation voltage. IC3 can be adjusted with selected resistors to provide a non-standard voltage output or to compensate for transducer nonlinearities. A remote sensing circuit senses temperature induced changes in lead wire resistance and automatically increases or decreases excitation output to maintain a steady, regulated, level. Figure 4-10 illustrates the ±15/+10V power supply circuit.

4-32. MULTIPLIER CIRCUIT.

4-33. The pulse multiplier circuit, Figure 4-9, is physically located on the +5V/+180V power supply board. Electrically, the multiplier is located between the voltage-to-counts converter and the counter. Basically, the multiplier produces a given number of pulses to the counter for every pulse coming from the converter. This technique enables a full scale signal input of 5.000V (which would normally produce a 10,000 count readout) to indicate 20,000, 30,000, 40,000, etc. counts in the digital display and still maintain full resolution.

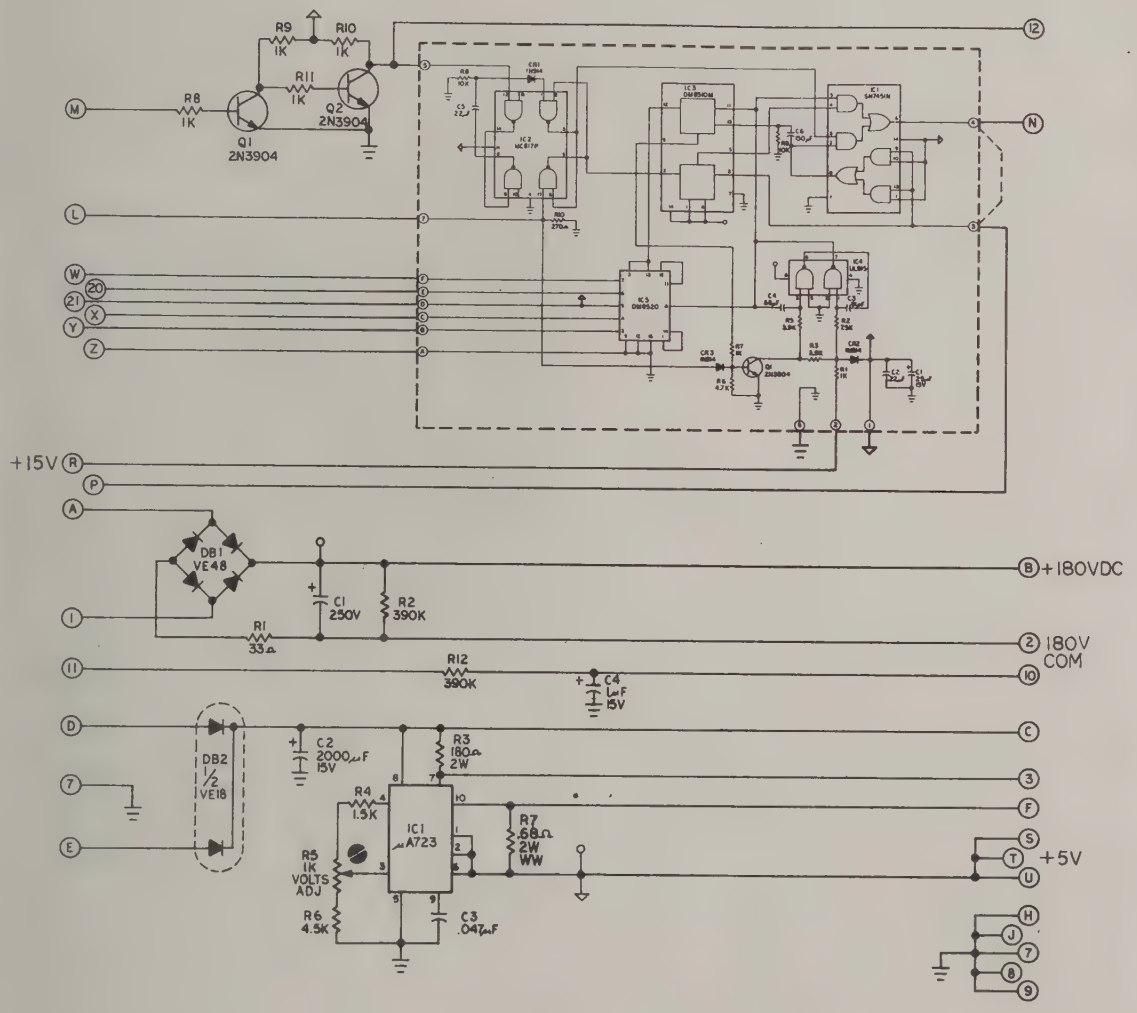


Figure 4-9. +5/+180V Power Supply Circuit

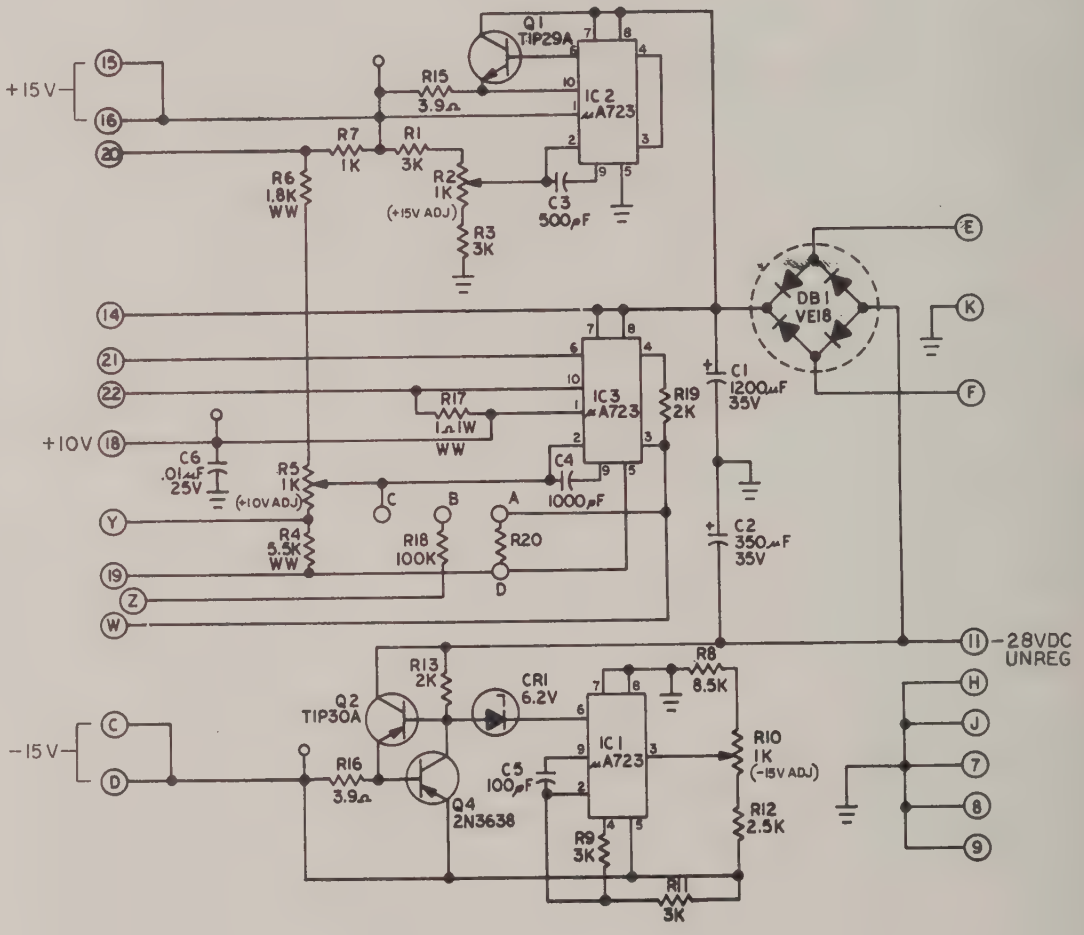


Figure 4-10. +10/±15V Power Supply Circuit

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. General.

5-3. This section provides the information and outlines the procedures necessary for the proper maintenance and service of the Model 8000SW Transducer Indicator. Information includes preventive maintenance (Paragraphs 5-6 through 5-13), troubleshooting (Paragraphs 5-14 through 5-27), repair and replacement of components (Paragraphs 5-28 through 5-41), and calibration and adjustment (Paragraphs 5-42 through 5-57). Test equipment recommended for checking and troubleshooting the instrument is listed in Table 5-1. Test instruments other than those listed can be used providing the performance equals or excees the required specifications.

5-4. Cover Removal.

5-5. Removal of the top cover exposes the circuit area shown in Figure 5-2. It will be necessary to remove the top cover for access to the test points (Figure 5-3) and for the replacement or installation of printed circuit boards and individual components. On most instruments, the top cover is removed by simply sliding it to the rear. If the cover does not slide easily, work a narrow bladed screwdriver between the rounded lip at the rear of the cover and the side frame of the instrument as shown in Figure 5-1. Pry rearward gently until the cover moves approximately 1/4 inch. Repeat procedure on opposite side. Alternate from side to side until friction is broken and cover slides easily. Normally it will not be necessary to remove the bottom cover of the instrument.

WARNING

115/230 V AC AND DC SUPPLY WIRES ARE EXPOSED WHEN INSTRUMENT COVER IS REMOVED. EXERCISE CAUTION DURING TROUBLESHOOTING, ADJUSTMENT, OR REPAIR.

Table 5-1. Recommended Test Equipment

TYPE	CHARACTERISTICS	USE	RECOMMENDED
Calibrator	Output accuracy at each point 0.1% or ±0.0003 mV/V whichever is greater	Trouble-shooting, Calibration	BLH Model 625 Precision Calibrator
AC/DC VTVM	1 mV to 100 V, 10 megohm impedance.	Trouble-shooting, Adjustment	
Decade Resistor	Total resistance, 10,000 ohms multiple of 1 ohm 0.05% accuracy.	Trouble-shooting	
Multimeter	1% accuracy at full scale input impedance 100 megohms	Trouble-shooting	Hewlett Packard Model 414A
Oscilloscope	200 kHz bandwidth	Calibration, Trouble-shooting	
Variable Power Transformer	0-230 Vac	Trouble-shooting	VARIAC
Standard Dead Weights	Class C or better-capacity to suit system	Calibration	

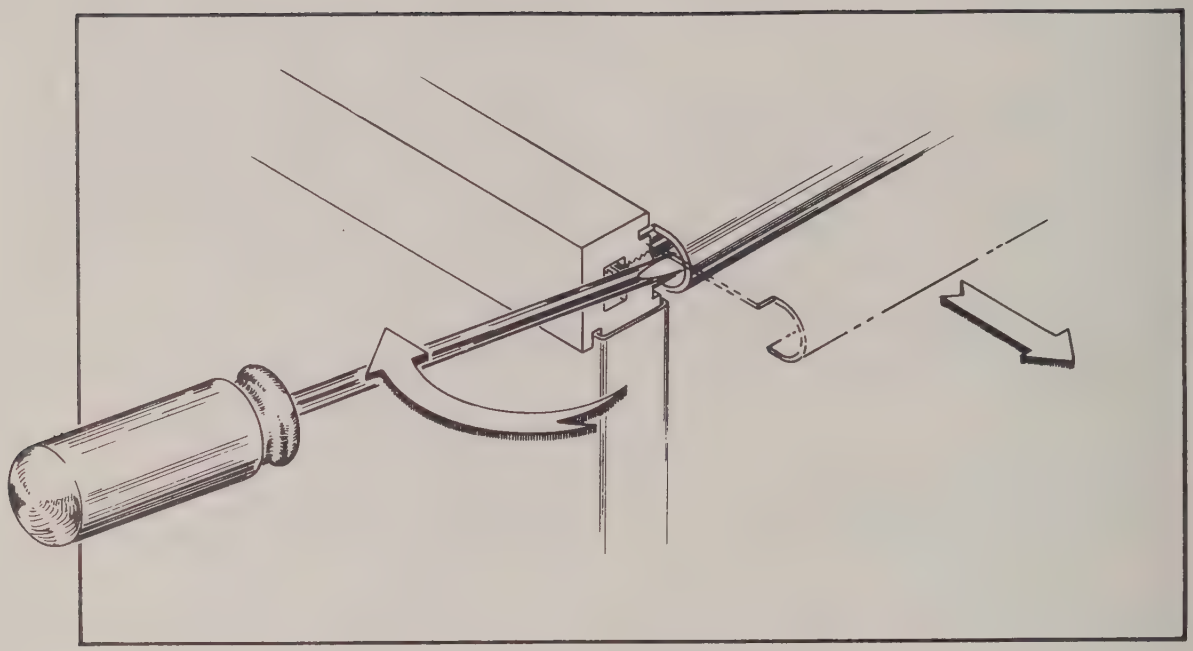


Figure 5-1. Cover Removal

5-6. PREVENTIVE MAINTENANCE.

5-7. Cleaning.

5-8. The indicator is enclosed in a vinyl coated aluminum cabinet and should be cleaned only with a damp cloth moistened in a solution of warm water and mild detergent. Do not use any chemical solvents or abrasive cleaners on the vinyl case or anodized aluminum surfaces. Use a soft brush to remove external dust accumulation. Loose dust within the chassis can be removed with dry, low-pressure, compressed air or a small vacuum cleaner.

Contamination of the switches, circuit boards, or edge connectors will cause high impedance leakage paths and subsequent deterioration of instrument performance. Avoid touching any of these circuits with the bare fingers, as skin oils are extremely contaminating. Do not use a pencil to trace circuits in the instrument. Graphite pencil lead is an excellent conductor; an accidentally introduced path of this type is often difficult to locate. If printed circuits do become contaminated during trouble-shooting or replacement, clean with a weak solution of warm water and mild detergent. Rinse thoroughly with clean water and allow to dry completely before operating. Do not use alcohol or any other cleaning solution except detergent and water. PC board edge connections can be cleaned with a fiberglass brush, if available, or with an ordinary pencil eraser as indicated in Figure 5-4.

CAUTION

DO NOT USE COMMERCIAL MOISTURE SEALING SPRAYS ON THE BOARDS. APPLICATION OF THESE AGENTS WILL CAUSE LEAKAGE PATHS AND SUBSEQUENT DETERIORATION OF INSTRUMENT PERFORMANCE.

5-9. Lubrication.

5-10. The pushbutton POWER and MODE switches are the only moving parts in the instrument. Each switch module has been lubricated during assembly and does not require further lubrication during normal operation. During continuous operation in extremely dusty environments however, an occasional application of a commercial spray cleaner such as Contacene or Miller-Stephenson MS-230 Contact Re-Nu, will lubricate and clear the switch contacts of possible contamination. Apply cleaner/lubricator through an extension nozzle at the rear of the switch stator block as shown in Figure 5-5.

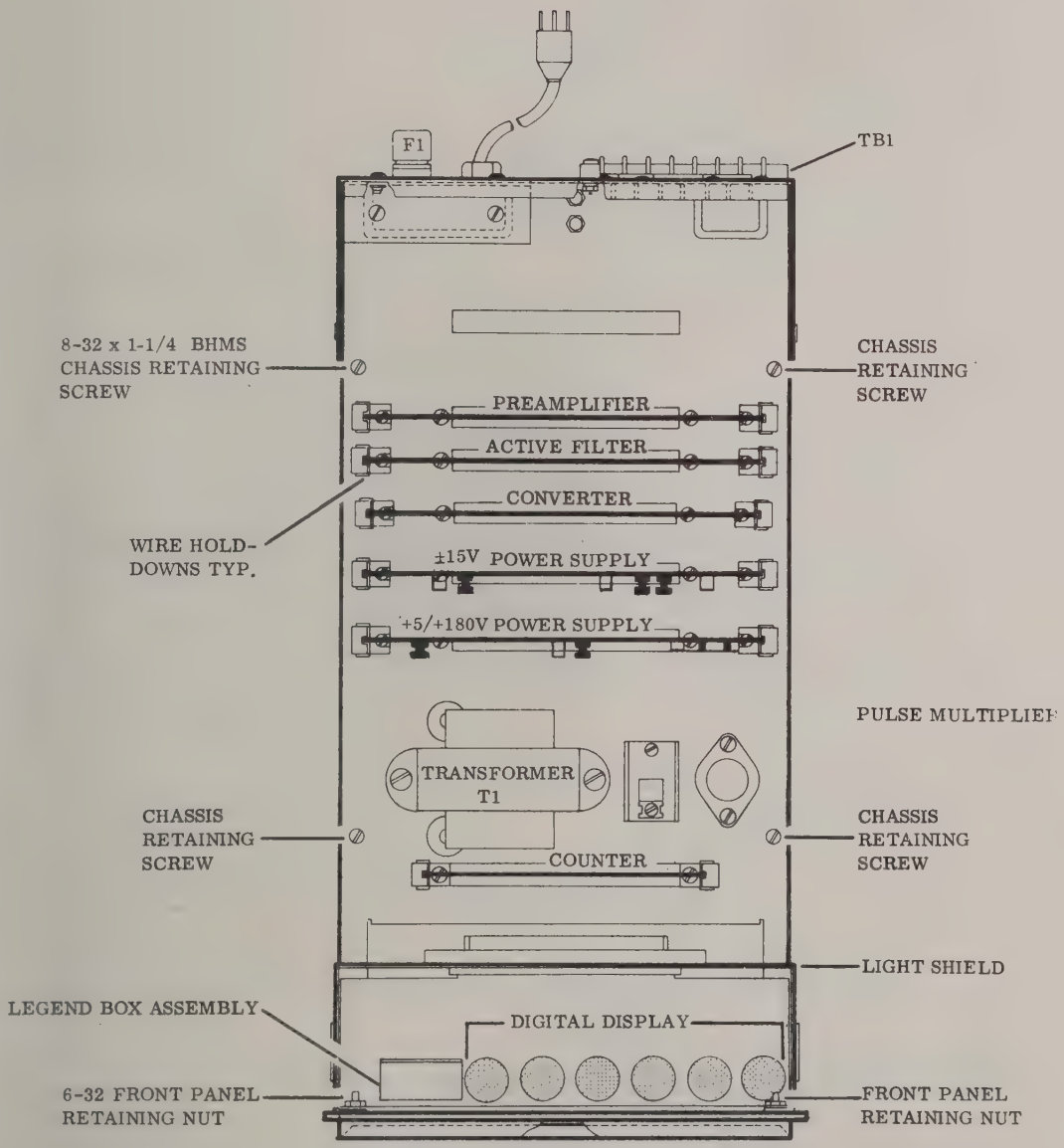


Figure 5-2. PC Board and Component Location (Top View)

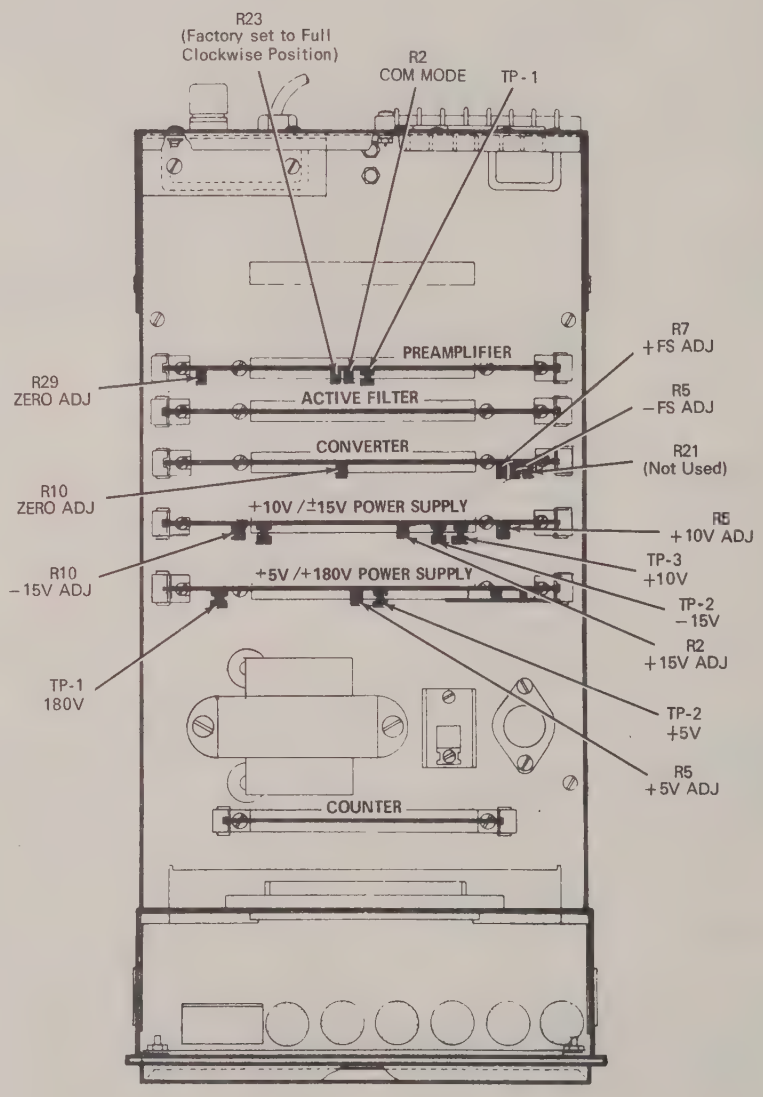


Figure 5-3. Test Point Location

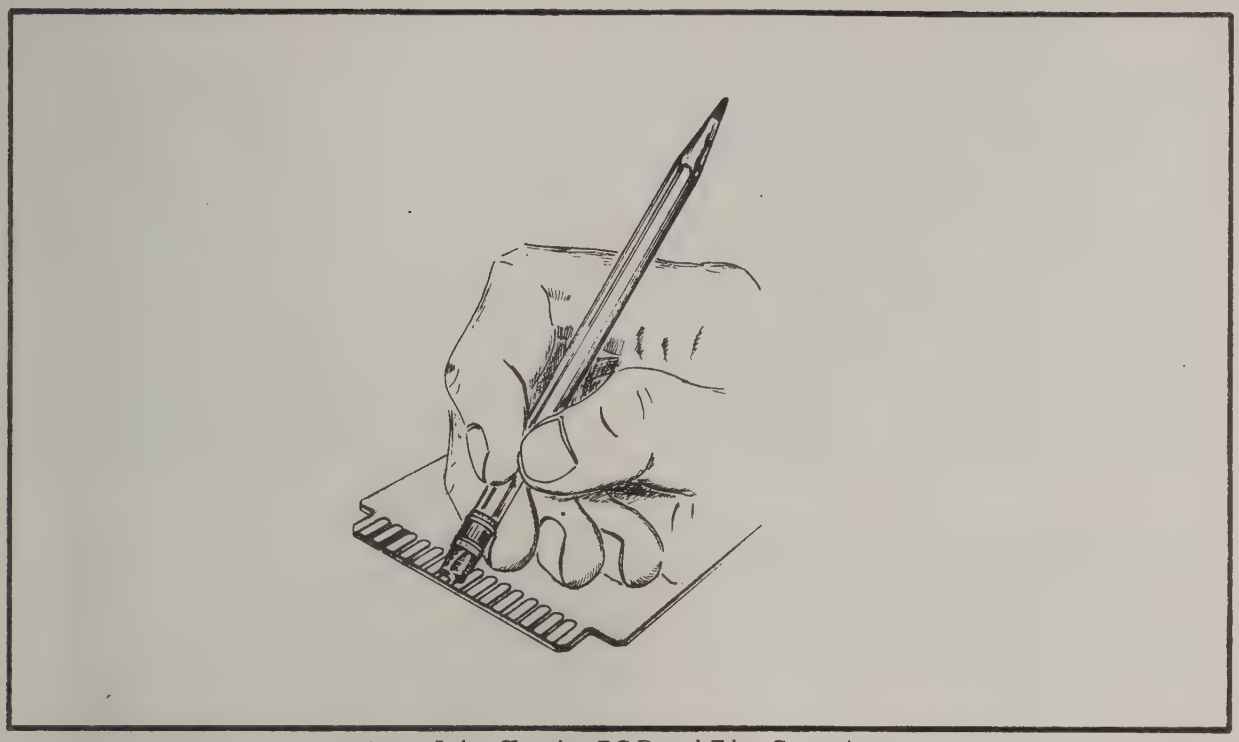


Figure 5-4. Cleaning PC Board Edge Connectors

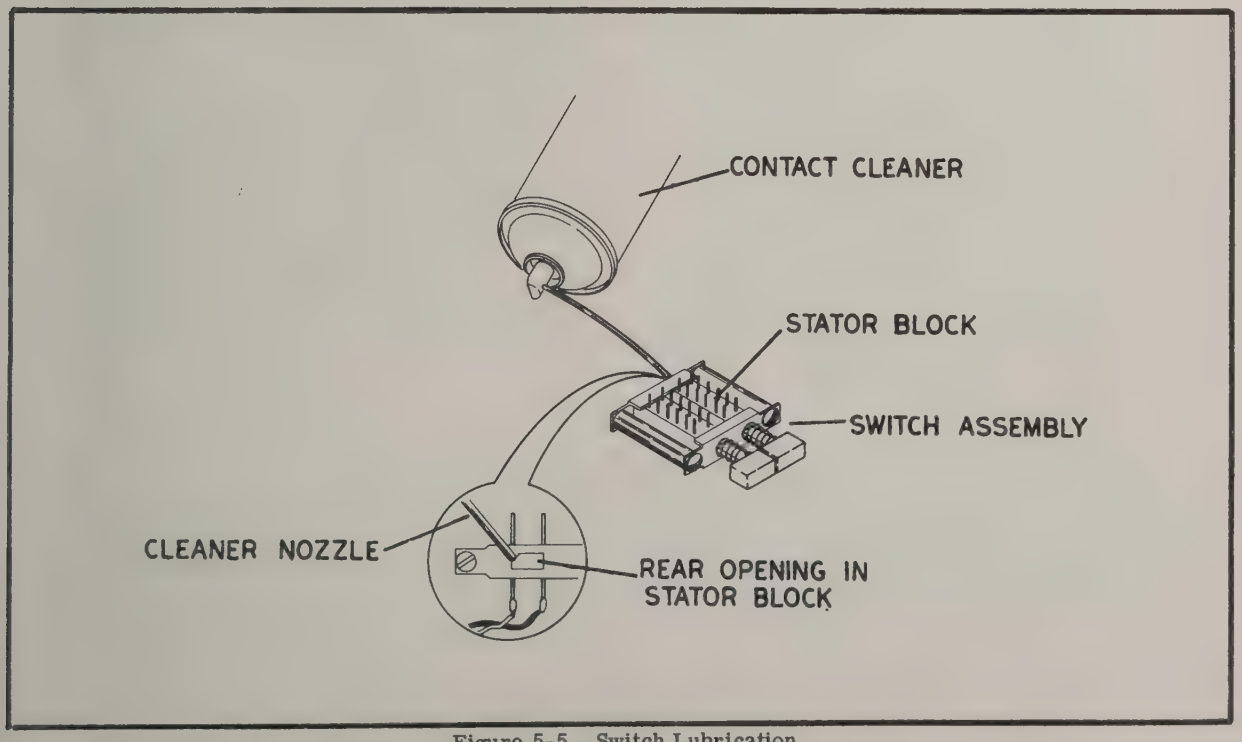


Figure 5-5. Switch Lubrication

5-11. Periodic Check.

5-12. BLH recommends that the entire system be performance tested on a quarterly basis (500 hours) if possible. In process applications, where 24 hour operation is common, performance test the system during scheduled maintenance/cleaning down-times or whenever possible. The calibration check (Section II) provides a valid check of instrument performance that can be performed without disrupting normal system operation. The instrument can be returned to BLH for a thorough overhaul whenever necessary and checked with test instruments traceable to the National Bureau of Standards. If user maintenance and calibration is not feasible, or if unusual problems or applications are encountered, a visit by a BLH Field Service Engineer can be arranged through any of the Sales/Service offices listed at the rear of the manual.

5-13. FACTORY SERVICE. If factory service is required, the instrument must be accompanied by RETURN AUTHORIZATION FORM 862. Upon examination of the instrument at the factory, a full report on the instrument condition along with a quotation on repair cost (if not under warranty) and delivery time will be submitted to the customer before work is begun.

5-14. TROUBLESHOOTING.

5-15. Preliminary.

5-16. The basic tools for troubleshooting are the schematic diagram at the rear of the manual, the theory information in Section IV, and the Troubleshooting Aid, Table 5-2, in this section. The most effective method of troubleshooting is to sectionalize the malfunction to a specific unit before attempting to localize the problem to a particular circuit or stage. Table 5-2 contains a summary of front panel symptoms that usually indicate the malfunction of a specific component or board; check before continuing troubleshooting process. Test point location and voltage limits at each point are illustrated and listed in Figure 5-3. Use of the extender board (BLH#411621-2, available as an accessory) facilitates checking of PC board mounted circuits.

5-17. SUBSTITUTION. Troubleshooting is greatly simplified if checking is done by replacing assembly suspected of malfunction with a spare unit known to be operating correctly. Where the malfunctioning assembly is found, the faulty component can be replaced if practicable or the entire assembly shipped to a BLH Sales/Service Office for repair or replacement.

5-18. External Circuit.

5-19. Substitution of a BLH Model 625 Calibrator for the transducers (Figure 5-6) at the rear panel of the Switching Unit will sectionalize the trouble either to the transducers/junction box(s)/ cabling and connections, or to the Indicator/Switching Unit. Set the calibrator to the output desired and check indicator readout. If the indicated output is correct for the range and step selected, the trouble lies with the external circuit. Inspect length of cable for breaks, cuts, or bruises. Check cable continuity in a weighing situation by moving the cable at the connector and by bending the cable in short loops, while an observer monitors the indicator. If indicator readings are erratic or intermittent, replace entire cable assembly or transducer. If the transducer(s) appears to be faulty, refer to the appropriate transducer operating and service manual for troubleshooting resistance and leakage data.

5-20. Power Circuit.

5-21. UNLIT DISPLAY. (If display is lit proceed to Paragraph 5-22). If the display is unlit, begin with the power source and power cable. Check that instrument is plugged in and that power source voltage is reaching the receptacle; check power cord for breaks, cuts, and bruises. If power cord is intact, check fuse F1. If F1 is blown, carefully inspect the electrical connections in the system for shorts before replacing with a 0. 3 ampere 250V time delay fuse (BLH#128552-8, Buss MDL 0. 3). Check positioning and functioning of POWER switch S1 by shorting the terminals with a test lead jumper. Transformer T1 can be checked in the instrument. Measure all voltages at the secondary windings of the transformer with line power applied to the primaries. If the voltages check with those given on the schematic diagram and there are no primary-to-secondary short circuits, the trouble should be confined to either the +5/+180V or the ±15/+10V power supply board. If the pulse multiplier option is not used, check that pins 3 and 4 on the +5/+180V board (see Paragraph 5-24) are jumpered. Continue below.

5-22. LIT DISPLAY. (The following also applied to unlit displays after proceeding through Paragraph 5-21). If the display is lit, the power circuit through Transformer T1 can be eliminated as a potential trouble source; begin troubleshooting at the +5/+180V power supply board. If pulse multiplier option is not used, check that pins 3 and 4 are

Table 5-2. Troubleshooting Aid

SYMPTOM	PROBABLE CAUSE	REMEDY
General non-performance, erratic, or incorrect operation.	Loose PC boards.	Push each board down firmly before continuing troubleshooting procedure.
Blank (unlighted) display.	Pins 3 and 4 on +5/+180V Power Supply Board open. Fuse F-1, line switch, power transformer.	Jumper pins 3 and 4. Replace defective components.
Superimposed digits.	IC drivers.	Replace defective driver.
Display drifts.	Auto-zero circuit.	Replace preamplifier board.
Frozen display (no response to signal).	E1-E2 open, external sampling rate control (if used), or transducer defective.	Jumper E1 and E2, replace external sample rate control, or transducer.
Saturated display in excess of overrange (over 17,000 counts).	Defective transducer or transducer cabling. Signal input or signal circuit open.	Check signal circuit.
Display indicates 00000 (no gain)	Shorted signal input.	Check signal input circuitry and transducers.
Individual digits displayed erratically.	Decoder driver.	Replace defective driver.
Improper tracking (poor linearity)	Transducer or preamplifier.	Replace cell with 625 Calibrator; if condition remains, replace Preamplifier.
Intermittent or erratic operation.	Contaminated edge connectors.	Clean boards (Paragraph 3-7).
Loss of multiplier (digital scaling) function.	Defective pulse multiplier assembly (+5/+180V power supply board).	Replaces multiplier assembly or +5/+180V power supply board.

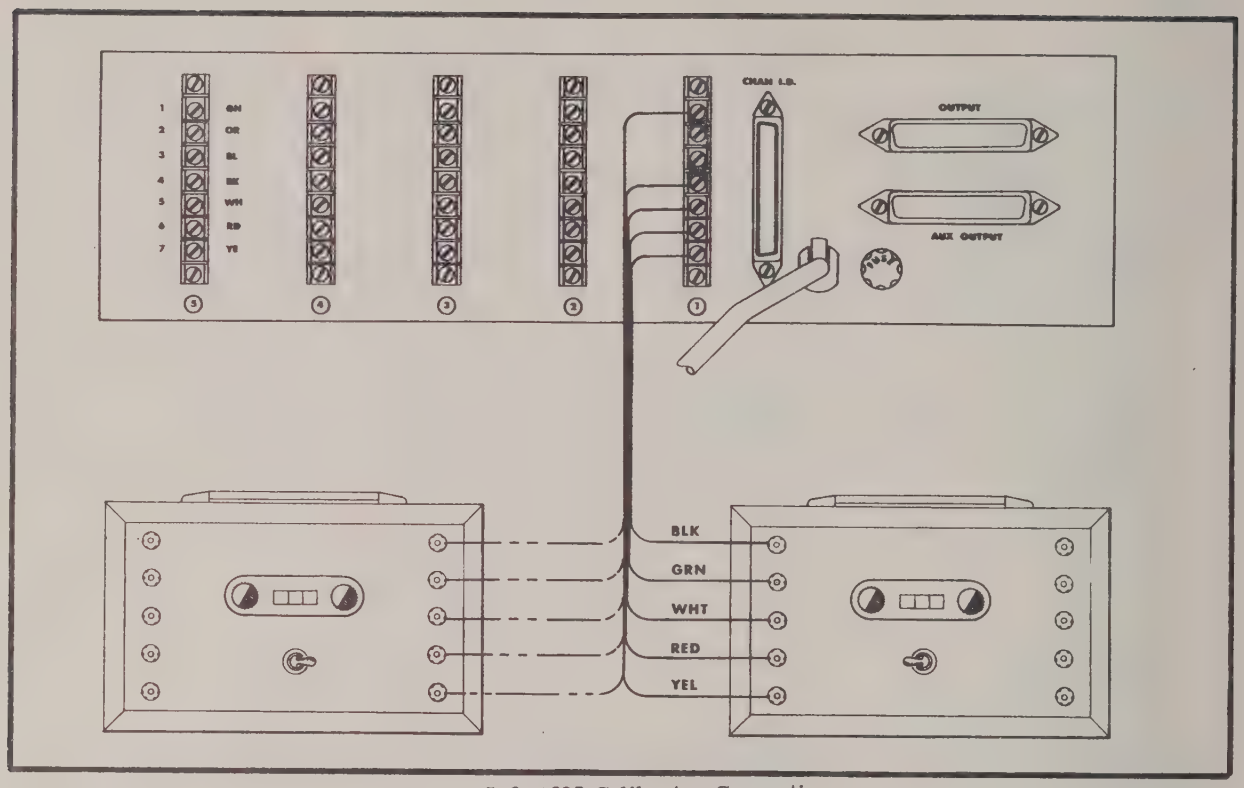


Figure 5-6. 625 Calibrator Connections

jumpered. Check voltage at TP1 (+180V) and TP2 (+5V). Pin 2 is 180V common. The junction of C2 and C1 (+ side of C2) is a convenient 5V common. Unregulated voltage output at TP1 should range from approximately 180V loaded to approximately 200V unloaded. Regulated voltage output at TP2 should be +5 volts, ±5%, over the specified line operating power of the instrument. Repeat above procedure at test points 1, 2, and 3 of the ±15V/+10V power supply board. Voltage output at TP1 should be -15V, regulated; at TP2, +15V regulated; at TP3, +10V regulated. All should be within ±5% of specified values.

5-23. If voltages are out of spec or non-existent, push down firmly on the board and recheck the voltages. If results are negative, give the board a thorough visual inspection. Look for loose components, loose wire connections, burned or broken components or similar conditions which would indicate a trouble source. If no obvious fault is indicated during the visual inspection, replace the board as a unit. See Paragraph 5-41 before repairing any printed circuit board.

5-24. PULSE MULTIPLIER CIRCUIT. (optional). A malfunctioning pulse multiplier assembly will be indicated by an unlit digital display or by the failure of the display to indicate a most significant digit other than 1. If the display is unlit, and the +5V/+180 power supply board is producing specified voltage, bypass the pulse multiplier by jumpering pins 3 and 4. If the display lights when pin 3 and 4 are jumpered, replace the multiplier.

5-25. Signal Circuit.

5-26. Generally, a malfunctioning signal circuit component (preamplifier, active filter (optional), A to D converter, counter and latch, and the digital display boards) can be identified by one or more of the characteristic symptoms listed in Table 5-2. A thorough understanding of the operation and function of each circuit (see Section IV) will help in diagnosing malfunctions not immediately apparent from front panel indications. If malfunction is not listed in Table 5-2, disconnect the transducers and substitute a known signal input e. g. 625 calibrator. Plug the instrument into a variable power transformer (Variac) and gradually lower the power input voltage to the lowest specified operating limit (103V for 115V instruments). This procedure will often cause marginal assemblies to fail completely or to indicate a malfunction listed in Table 5-2.

5-27. If the previous procedures are not effective, attempt to localize the malfunction by substitution (Paragraph 5-17). Once identified as faulty, inspect the board for obvious, easily repairable,

defects such as loose components or foil breaks. Some of the signal circuit boards contain plug-in ICs (flatpacks). It is sometimes possible to determine a faulty IC by close inspection or by substitution. Carefully inspect the gold plating on the IC leads. It must show no peeling or blistering and there must be no evidence of corrosion on the body of the lead. If the general appearance is satisfactory, swap the suspected IC for another of the same type (each board with replaceable ICs has at least two (2) of the same type) and check performance. If different conditions or symptoms result or if symptoms are reversed (superimposed digits shift to next tube when drivers are switched) replace if available or order new IC.

5-28. REPAIR & REPLACEMENT.

5-29. Field Replaceable Items.

5-30. BOARD REPLACEMENT. All of the instrument signal and power supply circuits are mounted on easily replaceable plug-in PC boards. With the exception of the digital display board, all are removed by snapping the wire hold-downs outward, grasping the board by the edges and drawing straight upward. Before removing any PC board, disconnect instrument power to avoid the possibility of accidentally shorting adjacent board components.

CAUTION

WHEN INSPECTING BOARDS DO NOT TOUCH EDGE CONNECTORS OR THE ETCHED CIRCUIT TRACE. DO NOT TRACE SIGNAL PATHS OR TEST COMPONENTS FOR LOOSENESS WITH A PENCIL AS IT IS POSSIBLE TO INTRODUCE HIGH IMPEDANCE LEAKAGE PATHS WITH GRAPHITE. (see Paragraph 5-8).

Replacement of the digital display board requires that the front panel of the indicator be dismounted. Proceed as follows:

a. Unplug instrument.

b. Remove top cover (Paragraph 5-4).

c. Locate and unscrew four (4) 8-32 x 1 1/4 BHMS chassis retaining screws (see Figure 5-2).

d. Slide chassis slightly forward until it protrudes about 2" from the case.

e. Unscrew the top two (2) 6/32 front panel retaining nuts with a nutdriver.

f. Carefully hold the chassis in place, turn the instrument upside down, and unscrew the two (2) bottom 6/32 front panel retaining nuts with an open end wrench.

g. Turn instrument upright; locate and unscrew the adjustment bracket retaining screw holding the display board.

h. Disconnect the board from connector J8 and draw forward out of chassis. Reassemble in reverse sequence.

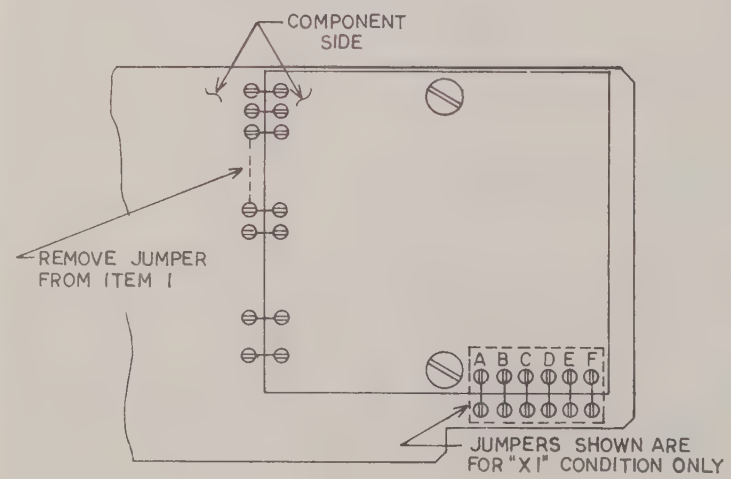
5-31. All PC Boards have been keyed to prevent insertion in wrong connector or backwards. (General rule: component side of boards always face to front of instrument). It is possible, however, for the key, a small phenolic chip, to be pulled out of the connector. If the chip is accidentally removed or if the connector is replaced, reinsert the key according to the Keying Chart, Table 5-3.

Table 5-3. Keying Chart

CONNECTOR NO.	KEY BETWEEN PINS:
J2	———
J3	———
J4	1-2 and 5-8
J5	———
J6	9-4 only
J7	2-3 and 8-9
J8	———

5-32. The pulse multiplier board is mounted on the +5/+180V power supply board with two (2) 4-40 x 1/4 binder head machine screws. To replace, remove the +5V /+180V power supply board and place foil side down on an insulated surface. Clip a heat sink (long nose pliers, heat sink tweezers, etc.) to a pulse multiplier jumper between the turret lugs. Place a low-heat soldering iron with a small tip directly on the multiplier board turret and pull up on the lead. Continue working around the perimeter of the board until all jumpers are disconnected. Unscrew the two (2) 4-40 x 1/4 BHMS and lift pulse multiplier board off the spacers. Mount the replacement board on the spacers and fasten with the retaining screws. Solder the jumpers to the turret lugs according to the jumpering sequence shown in Figure 5-7. Jumpering for desired multiplier function (X1, X2, X3, etc.) can be performed at the multiplier board or at the rear panel mating connector J1, (Figure 5-8), or at the 4000/4500 Switching Unit, where used.

5-33. IC REPLACEMENT. The only field replaceable ICs in the instrument are the plug-in flatpacks. Vertically mounted PC boards will have to be removed from the instrument to allow replacement of the integrated circuit modules; it is not necessary to remove horizontally mounted boards. ICs should be removed with a commercially available extractor tool (Augat, Inc. #T114-1-see Figure 5-9). If a commercial extractor tool is not available, a substitute can be easily fabricated from a piece of scrap aluminum or steel. When removing ICs, (disconnect power from the instrument if PC Board is not removed) grasp ends of module with tool or fingers and draw steadily upward until leads are free of socket. Do not bend leads. Before replacing an IC, check for proper alignment and polarity. The notch or depression in the end of the IC module must be positioned toward the socket end with the beveled corner as shown in Figure 5-10. Line replacement IC up with socket holes, set lightly into place and level carefully. Place thumb squarely on IC and press firmly into place.



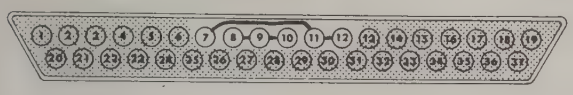
DESIRED MULTIPLICATION	JUMPER CODE A	B	C	D	E	F
X1	AS SHOWN					
X2						
X3						
X4						
X5						
X6						
X7						
X8						
X9						
X10						

Figure 5-7. Multiplier Jumper Sequence

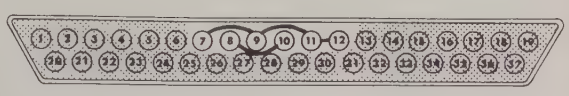
Note: Pin 7 is ground.
Pin 10 is +5V.

Multiply Readout X1
(No Jumpers)

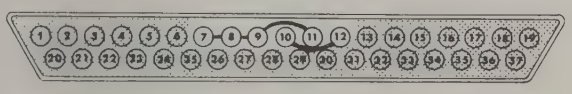
Multiply Readout X2
Jumper 8, 9, 10, & 11
Jumper 7-12



Multiply Readout X3
Jumper 8, 9, & 10
Jumper 7, 11, & 12

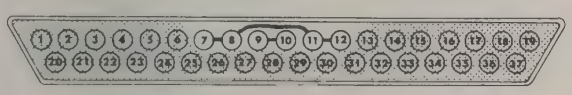


Multiply Readout X4
Jumper 8-10
Jumper 7, 9, 11, & 12

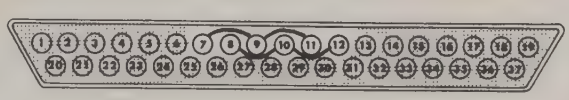


Multiply Readout X5
Jumper 7, 8, 9, & 11
Jumper 10 and 12

Multiply Readout X6
Jumper 7, 8, 9, & 12
Jumper 10-11



Multiply Readout X7
Jumper 7, 8, 11, & 12
Jumper 9-10



Multiply Readout X8
Jumper 7, 9, & 11
Jumper 8, 10 & 12

Multiply Readout X9
Jumper 7, 8, & 9
Jumper 10, 11, & 12

Multiply Readout X10
Jumper 7, 8, & 12
Jumper 9, 10, & 11

Figure 5-8. Multiplier Jumper Placement, Rear (wiring side) View Of Mating Connector

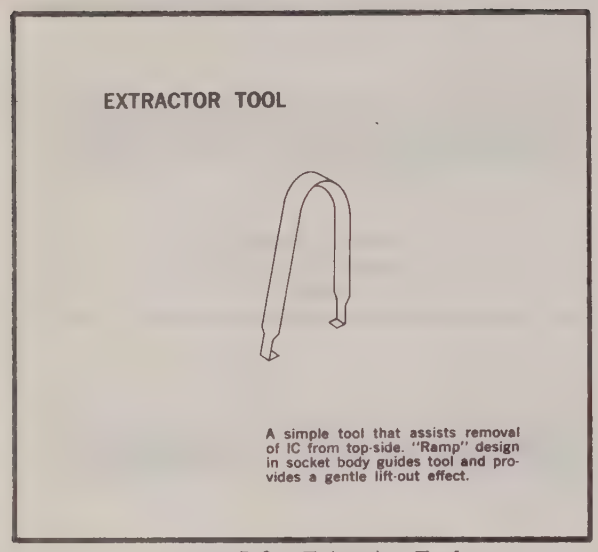

EXTRACTOR TOOL
A simple tool that assists removal of IC from top-side. "Ramp" design in socket body guides tool and provides a gentle lift-out effect.

Figure 5-9. Extractor Tool

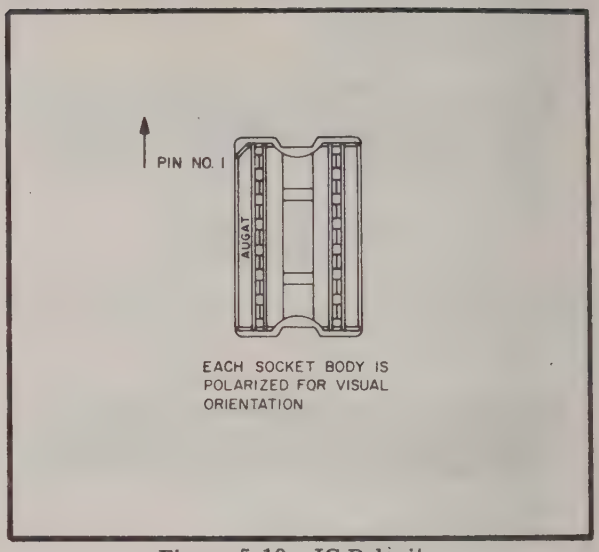


Figure 5-10. IC Polarity

5-34. DISPLAY TUBE REPLACEMENT. Replacements of digital display tubes necessitates that the chassis be partially removed from the case. Proceed according to the following sequence:

a. Unplug instrument.
b. Remove top cover (Paragraph 5-4).
c. Locate and unscrew four (4) 8-32 x 1 1/4 BHMS retaining screws. (see Figure 5-2).
d. Slide chassis forward until the readout tubes are accessible.
e. Pull and replace defective tube with National Electronics NL-84 (BLH# 137996-8) (same number for dummy zero tube).

IMPORTANT

THE BASES OF READOUT TUBES AND THE TUBE SOCKETS ARE NOT KEYED. IT IS POSSIBLE TO INSTALL A TUBE INCORRECTLY OR BACKWARDS. CHECK THAT NUMERALS ARE DIRECTLY TO THE FRONT BEFORE INSTALLATION.

5-35. LEGEND INDICATOR LAMP REPLACEMENT. Four (4) neon indicator lamps (ASA# A6A-BLH# 137994-8) are housed in the legend box assembly to the left of the most significant digital tube. The lamps indicate a positive or negative signal readout state, the legend, and the multiplier figure. The lamps are life rated for 25,000 hours - nearly three (3) years of 24 hour operation - and should not require frequent replacement. If replacement is necessary, remove the chassis to the extent described in Paragraph 5-34. The legend box assembly is a plug-in circuit mounted on the digital assembly board. Dismount by grasping the edges and pulling straight upward. Lamp replacement is as follows:

a. Unclip cover and window assembly from legend box.
b. Remove light diffuser lens over defective lamp.
c. Grasp one lead of the lamp with a pair of needle nose pliers.
d. Place a low heat (25 to 30 watts) small-tip soldering iron on either side of the board and pull up on the lead.
e. Clean component lead hole by heating the hole with the iron and inserting a wooden toothpick. Remove the toothpick after the solder has cooled.
f. Shape leads of new lamp with a bending fixture or a rounded plier jaw as shown in Figure 5-11 and insert them in lead holes.

CAUTION

IMPROPER BENDING OF THE LEADS CAN RESULT IN FRACTURE OF THE GLASS WHERE THE LEAD ENTERS THE PRESS AREA OF THE LAMP. BEND LEADS AROUND A CURVED SURFACE AT LEAST 1/8 INCH FROM THE GLASS.

g. Reheat with soldering iron and add a small amount of new 60/40 Rosin Core solder (Fed. Spec. QQS 571C - Kester 44 or equiv.) as required to form a good electrical connection.
h. Clean excessive flux from the connection and adjoining area.

i. Replace diffuser lens, cover, and window assembly.
j. Plug legend box assembly into PC Board and apply power to the instrument for test before reassembly chassis and case.

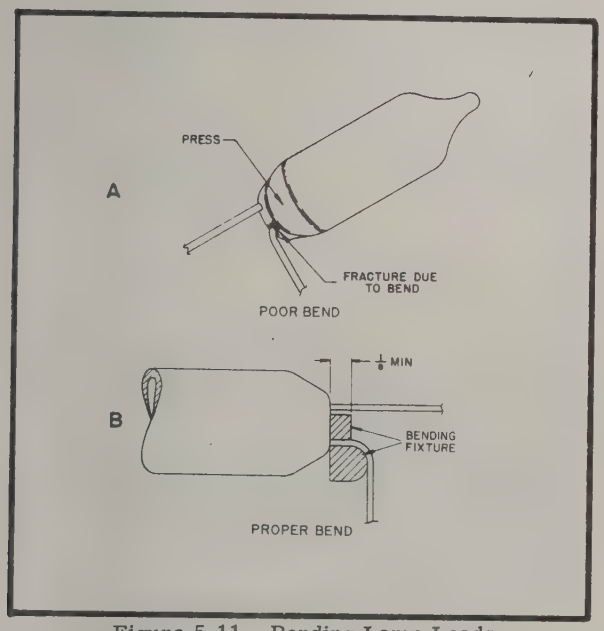


Figure 5-11. Bending Lamp Leads

NOTE

Neon lamps of this type require a 24-hour burn in period before functioning to full capacity. During the burn in, the lamp will be lit to approximately 50% brilliance and the diminished glow will appear to "walk" the length of the two electrodes. The glow will eventually elongate and stabilize at the end of the burn in period.

5-36. SWITCH AND CONTROL REPLACEMENT. The pushbutton POWER and MODE switches must be replaced as complete assemblies. Refer to Figure 5-2, and proceed as follows:

a. Unplug instrument and disconnect all signal and power output connectors or cables.
b. Remove entire chassis from case as follows:
   (1) Remove top cover (Paragraph 5-4).
   (2) Locate and unscrew four 8-32 x 1 1/4 BHMS, chassis retaining screws.
   (3) Slide chassis completely out of case and place upright on an insulated surface.
c. Unscrew the top two front panel retaining nuts with a nutdriver.
d. Turn the chassis upside down and unscrew the two bottom 6-32 front panel retaining nuts with an open end wrench.
e. Turn instrument upright; locate and unscrew the adjustment bracket retaining screw holding the display board to the light shield (black enclosure surrounding display board).
f. Disconnect the display board from connector J8 and draw forward out of chassis.
g. Note color code and pin position of switch wiring, and unsoldered wires.
h. Unscrew the two front switch assembly retaining screws holding the defective switch assembly to the subpanel.
i. Lift switch assembly out of subpanel notches.

Install the replacement switch assembly in reverse sequence.

NOTE

The calibration resistor (factory selected) is mounted across two pins on the MODE switch. If the MODE switch is replaced, reinstall the resistor on the new assembly. Recalibrate the instrument before returning to service. (see Paragraph 5-43).

5-37. With the exception of a few minor and easily recognized differences, the AMPL SPAN and BRIDGE ZERO potentiometers are replaced according to the procedure specified for switch replacement. Both controls are mounted on the panel subassembly and require the same degree of chassis disassembly for removal and replacement. Because both controls are in the control and calibration circuit, the instrument must be recalibrated before operation.

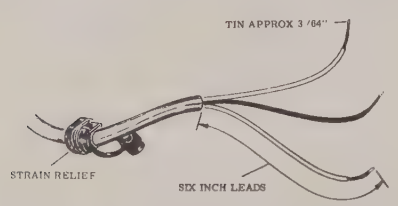
5-38. FUSE REPLACEMENT. Electrically, the entire instrument forward of the input side of the line filter is protected by a 0. 3A, 250V, time delay fuse. The fuse - the only one in the instrument - is designated F1 and is physically located in a fuse holder on the lower rear panel. Replace with BLH# 12853-2-8 (Buss, MDL 0. 3) after first determining and rectifying cause of overload.

5-39. TRANSFORMER REPLACEMENT. Transformer replacement is relatively simple and can be performed without removing the chassis from the instrument.

a. Slide top cover of instrument to rear (Paragraph 5-4).
b. Unplug PC Boards adjacent to the transformer (+5V/18V P. S. and counter assembly) to allow working room and to reduce possibility of damage.
c. Tag each lead - both primary and secondary - with the corresponding transformer coil lead identification number.
d. Unsolder leads.
e. Remove transformer from chassis assembly by unscrewing two 4-40 x 5/8 BHMS.
f. Replace transformer with BLH# 409044-1.

5-40. AC POWER CORD REPLACEMENT. The instrument is equipped with a six-foot, three-conductor power cable. When replacing, note lead connection points. The green lead is the ground lead and must be connected to the case. Removal and replacement of the power cable requires that the instrument chassis be removed from the case. The step by step replacement procedure is listed below:

a. Unplug instrument and disconnect all signal and power output connectors or cables.
b. Remove entire chassis from case as follows:
   (1) Remove top cover (Paragraph 5-4).
   (2) Locate and unscrew four 8-32 x 1 1/4 BHMS. Chassis retaining screws.
   (3) Slide chassis completely out of case and place upside down on an insulated surface.
c. Locate and unsolder the black lead from the fuse holder, white lead from phenolic solder lug terminal strip, and green ground lead from chassis ground lug.
d. Compress strain relief inside chassis with special tool if available or with pliers and push out of mounting hole.
e. Prepare new cable for installation as shown.



f. Thread new cable through strain relief and reinstall in chassis. Leave approximately two inches of sheathed cable inside case in addition to the six inch lengths of stripped, tinned leads.
g. Press strain relief into mounting hole to secure.
h. Solder new cable to proper connection points.

5-41. Servicing PC Boards.

5-42. Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick-drying acetate base cement having good electrical insulating properties. A break in the copper should be repaired by soldering a short length of tinned copper wire across the break. Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer.

5-43. ADJUSTMENTS.

5-44. General.

5-45. The indicator power supply, signal conditioning, and conversion circuits are comprised of high-stability components and seldom require adjustment. If, however, a malfunction, detected during system troubleshooting, requires that a component or an entire circuit be replaced, the following adjustments should be made prior to re-examining the calibration accuracy of the individual measuring channels.

5-46. Preliminary.

a. Set POWER switch to OFF position.
b. Disconnect the leads from one of the switching unit inputs and connect a 625 Calibrator to the input terminals as shown in Figure 5-6.
c. Set CHANNEL switch to the selected channel.
d. Set Calibrator for 0mV/V output.
e. If the indicator is equipped with a tare resistor common to all channels, one end of the resistor, which is installed on the plug-in calibration board of the preamplifier, must be unsoldered. This procedure is unnecessary where individual tare resistors are used--for example, tare resistors located in the load cell junction boxes.
f. Set indicator MODE switch to the OPER position and the POWER switch to ON.

5-47. Power Supply Adjustment.

5-48. The voltage trim potentiometers are located on the +5V/+180V power supply board and on the +10V/±15V board. Check voltages at the appropriate test point prior to making adjustments. Refer to Figure 5-3 for location of adjustments.

a. Connect a voltmeter (see Table 5-1) between the selected test point and chassis.
b. Rotate the corresponding adjusting potentiometer from one extreme position to the other several times to insure good slider contact.

c. Adjust for the specified voltage output. Note that the 180V output is unregulated and uncontrolled. This voltage may be as high as 200V unloaded. Check under load.

5-49. Zero Adjustments.

5-50. Instrument zero is established by setting the zero controls (front panel and internal trims) back from the output through the input. Refer to Figure 5-3 for control and test point locations.

a. Check that 625 calibrator is set at 0mV/V output.

b. Jumper pin J4- X of the converter connector to chassis ground.

c. Adjust potentiometer control R10 on the converter board for an indication of 00000 ±one count.

d. Remove jumper between pin J4-X and ground.

e. If the indicator is equipped with the active filter option, jumper pin J3-F of the filter connector to chassis ground. If no filter is included proceed to step "h".

f. Adjust potentiometer R5 on the filter board for an indication of 00000 ±one count.

g. Remove jumper between pin J3-F of the filter connector and ground.

h. Connect a jumper between test point TP-1 of the preamplifier and chassis ground.

i. Adjust potentiometer R29 on the preamplifier board for an indication of 00000 ±one count.

j. Remove jumper between test point TP-1 and ground.

k. Adjust the switching unit ZERO control for zero indication.

5-51. Converter Adjustment.

5-52. The following procedures are used to calibrate the A/D Converter section of the instrument which has a counts-to-voltage sensitivity of 2000 counts per volt, based on an excitation power supply output of 10Vdc. A 625 Calibrator, connected to an input of the companion switching unit, can be used as the signal source.

5-53. Voltage generated by the application of signal via the 625 calibrator can be measured by connecting a suitable voltmeter between pin J2-9(+) of the preamplifier connector and the instrument chassis. If the instrument is equipped with the active filter option, voltage measurements can be taken between pin J3-C(+) of the filter connector and the chassis. Proceed as follows:

a. Check instrument nameplate for calibration data, and set calibrator output accordingly. For example, if the instrument is calibrated for 1.6mV/V = Full Scale, set the calibrator for 1.6mV/V.

b. Measure the voltage at pin J2-9 of the preamplifier connector or pin J3-C of the filter connector, as applicable.

c. Assuming that a full scale input signal from the calibrator results in a 5Vdc measurement, the indicator should display a reading of +10,000 counts.

d. If indicator reading is incorrect, adjust potentiometer R7 (+Full Scale ADJUST) on the converter board until reading is correct.

e. Without changing the setting of the calibrator, reverse the RED and WHITE leads connected to the switching unit input terminal block; the indicator should display the correct reading in a negative polarity.

f. If reading in step "e" is incorrect, adjust potentiometer R5 (-Full Scale ADJUST) on the converter board for the correct reading.

-NOTE-

If the exact calibration setting is not available from the calibrator, set the calibrator for nearest value below the desired setting and measure preamp or filter output voltage. The converter count output should be proportional. For example, if a voltage measurement of 4.8Vdc resulted from a lower output setting of the calibrator, the correct display would be 9600 counts.

5-54. If the instrument has been wired for a multiplier (see Section II, Paragraph 2-28), the test readings will be higher by a factor of the multiplier employed. For example, if connector J1 was wired for an X3 multiplier, the reading in step "c" would be 30,000; the reading in the preceeding note would be 28,800 etc. The counts-to-voltage ratio, however, remains the same.

5-55. Common Mode Rejection Adjustment.

5-56. The final adjustment that should be made to the instrument before checking the calibration is the COMMON MODE REJECTION ADJUSTMENT. In this procedure, potentiometer R2 on the preamplifier board is adjusted until the preamplifier rejects signals common to both inputs, for example, capacitive pickup in the signal cable, etc.

5-57. In order to prevent interference from the auto zero circuit during the adjustment, the auto zero should be disabled. The simplest methods for accomplishing this is to remove the preamplifier board from its connector (J2) and mask pin F of the board with a piece of cellophane tape cut to the proper length and width. The auto zero will cease to function when the board is reinserted in its connector. Proceed as follows:

a. Reconnect the 625 Calibrator leads to the switching unit input terminal block color-for-color, then, at the calibrator end, connect the RED as well as the WHITE wire to the WHITE binding post of the calibrator. This setup will apply 5Vdc as common mode signal to the input circuit.

b. Observe the reading displayed by the instrument. Note that this reading may be offset from zero as a result of disabling the auto zero. The offset, however, has no affect on the procedure.

c. Remove the GREEN lead from the calibrator and again note the reading displayed on the instrument.

d. Repeatedly remove and replace the GREEN lead and adjust potentiometer control R2 on the preamplifier board until the indicator reads approximately the same (±5 counts) with and without the GREEN lead connected.

5-58. Upon completion of the COMMON MODE ADJUSTMENT, remove the cellophane tape from pin F of the preamplifier board and clean the pin thoroughly before returning the board to the instrument. Disconnect the calibrator from the switching unit and reconnect the normal signal source to the unit. If a tare resistor was unsoldered during the preliminary operations, resolder the resistor to its original connection.

5-59. CALIBRATION.

5-60. The calibration of the indicator/switching unit combination should be checked whenever components or circuits have been replaced or controls of the individual circuits adjusted. The simplest method for checking the individual weigh channels is to use the self-check procedure described in Figure 2-10 of this manual. Other calibration methods, which can be used to check the indicator independent of the switching unit or the overall system, are outlined in Section II, Paragraph 2-54.

5-61. KITS & OPTIONS.

5-62. General.

5-63. Maintenance of kits and options, if applicable, is covered in the document accompanying the device. An exception is the pulse multiplier assembly which is covered in this section. When neither the active filter nor the pulse multiplier is used, the gap in the circuit must be bridged by jumpering. The jumper points are well defined both on the boards and on the schematic diagram.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for identifying and ordering replacement parts. Figure 6-1 is an overall schematic diagram of the instrument and parts locator (reverse side). Table 6-1 lists in alpha-numeric order by reference designator and provides the following information on each part:

a. BLH part number.

b. Total quantity used in the instrument (TQ column). Quantity listed where item first appears on list.

c. Recommended spares for year application in a remote location (or 2000 hours). RS column.

6-3. ORDERING INFORMATION.

6-4. To obtain replacement parts, address order or inquiry for parts to the nearest BLH Sales/Service Office (see list at rear of this manual) or direct to BLH. Identify parts by BLH part number.

6-5. To order parts not listed in this section provide the following:

a. Model number of instrument.

b. Serial number of the unit.

c. Description of the part including function and location.

DESIGNATORS

A	= assembly	F	= fuse	P	= plug	TC	= thermocouple
B	= motor	FL	= filter	Q	= transistor	V	= vacuum tube, neon bulb, photocell etc.
BT	= battery	HR	= heater	QCR	= transistor-diode		
C	= capacitor	J	= jack	R	= resistor	W	= cable
CR	= diode	K	= relay	RT	= thermistor	X	= socket
DL	= delay line	L	= inductor	S	= switch	XDS	= lampholder
DS	= lamp	M	= meter	T	= transformer	XF	= fuseholder
E	= misc electronic part	MP	= mechanical part	TB	= terminal board	Z	= network

ABBREVIATIONS

A	= ampere (s)	H	= henry (ies)	nA	= nanoampere (s) = 10^{-9}	Se	= selenium
Ag	= silver	Hg	= mercury	NC	= normally closed	sect	= section (s)
Al	= aluminum	Hz	= cycles per second	Ne	= neon	Si	= silicon
Au	= gold			NO	= normally open	sl	= slide
		ID	= inside diameter	NPO	= negative positive zero (zero temperature coefficient)	SPDT	= single-pole double-throw
C	capacitor	impg	= impregnated			SPST	= single-pole single-throw
cer	= ceramic	incd	= incandescent	ns	= nanosecond (s) = 10^{-9}		
coef	= coefficient	ins	= insulation (ed)			Ta	= tantalum
com	= common			Ω	= ohm (s)	tog	= toggle
comp	= composition	KΩ	= kilohm (s) = 10^{+3}	OD	= outside diameter	tol	= tolerance
conn	= connection	kg	= kilogram			trim	= trimmer
		KHz	= kilocycle (s) = 10^{+3}	p	= peak	TSTR	= transistor
dep	= deposited			pc	= printed circuit		
DPDT	= double-pole double-throw	L	= indicator	pF	= picofarad (s) = 10^{-12}	V	= volt (s)
		lin	= linear taper	piv	= peak inverse voltage	vacw	= alternating current working volt (s)
DPST	= double-pole single-throw	log	= logarithmetic taper	p/o	= part of	var	= variable
				pos	= position (s)	vdcw	= direct current working volt (s)
		m	= milli = 10^{-3}	poly	= polystyrene		
elect	= electrolytic	mA	= milliampere (s) = 10^{-3}	pot	= potentiometer	W	= watt (s)
encap	= encapsulated	mH	= millihenry (s) = 10^{-3}	p-p	= peak-to-peak	w/	= with
		MHz	= megacycle (s) = 10^{+6}	prec	= precision (temperature coefficient, long term stability, and/or tolerance.)	w/o	= without
F	= farad (s)	MΩ	= megohm (s) = 10^{+6}			ww	= wirewound
FET	= field effect transistor	met film	= metal film				
fxd	= fixed	mfr	= manufacturer			*	= optimum value selected at factory, average value shown (part may be omitted)
		mtg	= mounting				
GaAs	= gallium arsenide	μ	= micro = 10^{-6}	R	= resistor		
GHz	= gigacycle (s) = 10^{+9}	my	= Mylar®	rms	= root-mean-square		
gd	= guard			rot	= rotary		
Ge	= germanium						
grd	= ground (ed)						

® Dupont de Nemours

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
END ITEM	415565-4			Model 8000SW Transducer Indicator		
A1	410552-4		1	Assembly, Chassis		
A2	411378-2		1	Assembly, Front Sub-Panel		
A3	412496-3		1	Assembly, 5-Digit Display		
	412497-3			Assembly, 6-Digit Display		
A4	412504-2		1	Assembly, Legend Box		
A5	409725-3		1	Assembly, Analogic Counter		
A6	409776-2		1	Assembly, +5V/+180V Supply Board		
A6A1	409772-2		1	Assembly, Pulse Multiplier (optional)		
A7	409780-2		1	Assembly, +15V Supply Board		
A8	413901-2		1	Assembly, A/D Converter		
A9	417494-2		1	Assembly, Active Filter (optional)		
A10	419417-2		1	Assembly, Preamp/Switches		
A11	411621-2		1	Assembly, Extender Board (optional)		
A1	410552-4		1	Assembly, Chassis		
A1C1	141905-8		1	C: 0.01μF, 1KV, Filter		
A1C2-C5	142001-8		1	C: 470pF		
A1F1	128552-8		1	Fuse, 0.3A, SB		
A1J1	137405-8		2	Conn: 37-pin P/O Cable Harness		
J2-J7	137384-8		6	Conn: 22-pin		
J8	138418-8		1	Conn: 22-pin P/O Cable Harness		
J9				Same as J1		
A1L1, L2	136731-8		2	Choke: Filter 680μH		
A1MP1	137390-8		1	Window Assembly		
MP2	412432-1		2	PC Board Guide		
MP3	410485-1		4	PC Board Guide		
MP4	410906-1		1	Bracket, Filter		
MP5	412213-1		6	Spring, Hold Down		
MP6	411379-3		1	Panel, Front		
MP7	129055-8		2	#6 Lug		
A1P1	137404-8		1	Conn: 37-Pin (Mates with J1)		
A1Q1	137785-8		1	Scon: Transistor PNP 2N1168		
Q2	137824-8		1	Scon: Transistor NPN TIP29A		
	137045-8		1	Heat Sink, Q2		
A1T1	409044-1		1	Transformer, Power		
A1TB1	138407-8		1	Terminal Strip, TB1		
TB2	138408-8		1	TB2 (optional)		
A1XF1	131050-8		1	Fuseholder, F1		
A2	411378-2		1	Assembly, Front Sub-Panel		
A2MP1	410662-2		1	Sub-panel		
MP2	410948-1		4	Spacer		
A2R1-R2				NOT USED		
R3	DC 1/4		1	R: Select WW, 0.05% - 15909		
A2S1-S2	411501-1		2	Switch: pushbutton		
A3	412496-3		1	Assembly, 5-Digit Display		
	412497-3			Assembly, 6-Digit Display		
A3A1	412264-2		1	Assembly, Display PC Board		
A3MP1	412495-3		1	Bracket, Assembly Mounting		
MP2	412498-1		AR	Bracket, PC Board Mounting		
A3V1-V5	137996-8		5	Tube, Nixie (5-digit display)		
V6			1	Same as V1 (6-digit display)		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A3A1	412264-2		1	Assembly, PC Board		
	412265-2		1	PC Board		
A3C1	137988-8		1	C: 15μF, 10V		
A3CR1-CR11	137989-8		11	Scon: diode 1N4148 (CR3 optional)		
A3IC1	137984-8		5	Scon: Integrated Circuit SN744IN		
IC2-IC5				Same as IC1		
A3Q1-Q9	137990-8		9	Scon: Transistor 2N4410 (Q3 optional)		
A3R1&R8	127238-8		4	R: FXD, 47K, 1/2W, 10%		
R9&R10				Same as R1&R8		
A3R2-R7	138193-8		6	R: FXD, 8.2K, 1/8W, 1%		
R11	138246-8		9	R: FXD, 22K, 1/8W, 1%		
A3R12	138245-8		1	R: FXD, 5.6K, 1/8W, 1%		
R13-R21				Same as R11 (R14 optional)		
A3XIC-IC5	137983-8		5	Socket, Integrated Circuit		
A3XV1-						
XV6	137982-8		6	Socket, Nixie Tube		
A4	412504-2		1	Assembly, Legend Box		
A4DS1-DS4	143069-8		4	Lamp		
A4MP1	412298-2		1	PC Board		
MP2	410966-2		1	Legend Box		
MP3	412507-1		1	Cushion		
MP4	410981-1		3	Divider		
MP5	413730-1		1	Filter		
MP6	410967-1		1	Cover		
MP7				Legend (as ordered)		
MP8	137998-8		2	Guide Socket		
MP9	137997-8		1	PC Contacts		
A5	409725-3		1	Assembly, Decade Counter		
A5MP1	410845-3		1	PC Board		
A5C1	137988-8		1	C: 15μF, ±10%, 10V		
A5CR1	137739-8		1	Diode: IN914		
A5IC1	138513-8		1	Scon: Integrated Circuit, U6A901659X		
IC2-IC6	138515-8		5	Scon: Integrated Circuit, SN7475N		
IC7	137466-8		1	Scon: Integrated Circuit, SN158094N		
IC8-IC12	138514-8		5	Scon: Integrated Circuit; SN7490		
A5Q1	137800-8		1	Scon: Transistor NPN 2N3904		
A5R1	138190-8		1	R: FXD, 4.7K, 10%, 1/4W, CC		
R2	138178-8		3	R: FXD, 470Ω, 10%. 1/4W, CC		
R3	138182-8		1	R: FXD, 1K, 10%, 1/4W, CC		
R4	138175-8		1	R: FXD, 270Ω, 10%, 1/4W, CC		
R5-R6				Same as R2		
A6	409776-2		1	Assembly, +5V/+180V Supply		
	409777-2		1	PC Board		
A6C1	137793-8		1	C: 4μF, 250V		
C2	137794-8		1	C: 2000μF, 15V		
C3	137795-8		1	C: .047μF		
C4	137796-8		1	C: 1μF, 15V		
A6CR1	137797-8		1	Scon: Quad Diode VE48		
CR2	137798-8		1	Scon: Dual Diode VE18		
A6IC1	137799-8		1	Scon: Integrated Circuit μA723		
	137801-8		1	Heat Sink (IC1)		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A6Q1-Q2	137800-8		2	Scon: Transistor NPN 2N3904		
A6R1	129817-8		1	R: FXD, 33Ω, 1/2W, CC, 10%		
R2	137790-8		2	R: FXD, 390K, 1/4W, CC, 10%		
R3	132364-8		1	R: FXD, 180Ω, 2W, CC, 10%		
R4	140849-8		1	R: FXD, 1.5K, 1/4W, CF, 1%		
R5	137789-8		1	R: Variable, 1K		
R6	137788-8		1	R: FXD, 4.5K, 1/4W, CF, 1%		
R7	138242-8		1	R: FXD, 0.68Ω, 2W, WW, 10%		
R8-R11	138182-8		4	R: FXD, 1K, 1/4W, CC, 5%		
R12				Same as R2		
A6A1	409772-2		1	Assembly, Pulse Multiplier (optional)		
	409773-2		1	PC Board		
A6A1C1	137735-8		1	C: 25μF, 15V		
C2	137826-8		2	C: .22μF, 10V		
C3	137737-8		1	C: 91pF, 300V		
C4	137827-8		1	C: 68pF, 300V		
C5				Same as C2		
C6	137738-8		1	C: 150pF, 300V		
A6A1CR1-CR3	137739-8		3	Scon: Diode IN914		
A6A1IC1	137740-8		1	Scon: Integrated Circuit SN745IN		
IC2	137741-8		1	Scon: Integrated Circuit MC817P		
IC3	137742-8		1	Scon: Integrated Circuit DM8510N		
IC4	137828-8		1	Scon: Integrated Circuit U8A991428X		
IC5	137744-8		1	Scon: Integrated Circuit DM8520		
A6A1Q1	137800-8		1	Scon: Transistor NPN 2N3904		
A6A1R1	138182-8		2	R: FXD 1K, 1/4W, 10%		
R2	138193-8		1	R: FXD 8.2K, 1/4W, 10%		
R3	138189-8		2	R: FXD 3.9K, 1/4W, 10%		
R4				NOT USED		
R5				Same as R3		
R6	138190-8		1	R: FXD, 4.7K, 1/4W, 10%		
R7				Same as R1		
R8-R9	138179-8		2	R: FXD 10K, 1/4W, 10%		
R10	138175-8		1	R: FXD 270Ω, 1/4W, 10%		
A7	409780-2		1	Assembly, ±15V Supply		
	409781-2		1	PC Board		
A7C1	137819-8		1	C: 1100uF, 50V		
C2	137820-8		1	C: 500uF, 50V		
C3	133269-8		3	C: .02uF,		
C4				Same as C3		
C5	137821-8		1	C: 100pF, 300V		
C6	137811-8		1	C: .01μF, 25V		
C7				Same as C3		
A7CR1	137808-8		1	Scon: Diode, Zener 6.2V, IN5234		
CR2	137798-8		1	Scon: Diode Bridge VE18		
A7IC1-IC3	137799-8		3	Scon: Integrated Circuit μA723		
	137801-8		3	Heat Sink, Integrated Circuit		
A7Q1	137824-8		1	Scon: Transistor NPN TIP29A		
Q2	137825-8		1	Scon: Transistor PNP TIP30A		
Q3				NOT USED		
Q4	142099-8		1	Scon: Transistor PNP 2N3638		
	137045-8		2	Heat Sink, Q1 and Q2		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A7R1	138736-8		4	R: FXD 3010Ω, 1/4W, 1%, mF		
R2	137789-8		3	R: Variable 1K		
R3				Same as R1		
R4	137809-8		1	R: FXD 5.5K, 1/4W, 1%, WW		
R5				Same as R2		
R6	137975-8		1	R: FXD 1.8K, 1/4W, 1%, WW		
R7	138182-8		1	R: FXD 1K, 1/4W, 10%, CC		
R8	137817-8		1	R: FXD 8.5K, 1/4W, 1%, CF		
R9				Same as R1		
R10				Same as R2		
R11				Same as R1		
R12	137818-8		1	R: FXD 2.5K, 1/4W, 1%, CF		
R13	138186-8		1	R: FXD 2.2K, 1/4W, 10%		
R14				NOT USED		
R15-16	138244-8		2	R: FXD 3.9Ω, 1/2W, 10%		
R17	138243-8		1	R: FXD 1Ω, 2W, 10%, WW		
R18				NOT USED		
R19	140852-8		1	R: FXD 2K, 1/4W, 1%, CF		
R20			1	R: FXD Select, 1/4W, 1%, CF		
A8	412212-1		1	Assembly, Analogic Converter (alternate, early versions, no breakdown)		
A8	413901-2		1	Assembly, A-D Converter		
	413902-2		1	PC Board		
A8C1	137454-8		3	C: 6.8μF, 20V		
C2				Same as C1		
C3				Same as C1		
C4				NOT USED		
C5	137834-8		4	C: 47pF		
C6				Same as C5		
C7				Same as C5		
C8	139537-8		1	C: 0.027μF, 100V, 5%		
C9				NOT USED		
C10				NOT USED		
C11	137457-8		5	C: 0.01μF, 150V		
C12	139533-8		1	C: 0.47μF, 50V		
C13				NOT USED		
C14				Same as C5		
C15				NOT USED		
C16	137456-8		1	C: 680pF		
C17				Same as C11		
C18				Same as C11		
C19				Same as C11		
C20				Same as C11		
C21	137539-8		1	C: 0.001μF		
C22				NOT USED		
C23				NOT USED		
C24				NOT USED		
C25				NOT USED		
C26	137453-8		1	C: 2.2μF		
C27	139517-8		1	C: 0.0027μF, 100V		
A8CR1				NOT USED		
CR2				NOT USED		
CR3	137739-8		12	Scon: Diode, IN914		
CR4				Same as CR3		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A8CR5				Same as CR3		
CR6				Same as CR3		
CR7				Same as CR3		
CR8				Same as CR3		
CR9				Same as CR3		
CR10				Same as CR3		
CR11				Same as CR3		
CR12				Same as CR3		
CR13				NOT USED		
CR14				NOT USED		
CR15				NOT USED		
CR16				NOT USED		
CR17				Same as CR3		
CR18				Same as CR3		
A8IC1	137908-8		3	Scon: Integrated Circuit UA741		
IC2	137463-8			Scon: Integrated Circuit, LM311		
IC3				Same as IC1		
IC4				Same as IC1		
IC5	137464-8		2	Scon: Integrated Circuit SN1 5849N		
IC6	137465-8		1	Scon: Integrated Circuit SN1 5837N		
IC7	137466-8		1	Scon: Integrated Circuit SN1 58094N		
IC8				Same as IC5		
IC9	137467-8		1	Scon: Integrated Circuit SN 7451N		
A8Q1	137830-8		4	Scon: Transistor, FET U1899E		
Q2				Same as Q1		
Q3				Same as Q1		
Q4	138150-8		1	Scon: Transistor, UNI Junction, 2N2646		
Q5	137854-8		2	Scon: Transistor, Dual Fet U232		
Q6				Same as Q5		
Q7				Same as Q1		
Q8	137800-8		6	Scon: Transistor, NPN, 2N3904		
Q9	137917-8		4	Scon: Transistor, PNP, 2N3906		
Q10				NOT USED		
Q11				Same as Q8		
Q12				Same as Q9		
Q13				Same as Q8		
Q14				Same as Q9		
Q15				Same as Q8		
Q16				Same as Q9		
Q17				Same as Q8		
Q18				Same as Q8		
A8R1				NOT USED		
R2				NOT USED		
R3	138186-8		2	R: FXD 2.2K, 1/4W, 10%, CC		
R4			1	R: FXD Select, WW		
R5	137911-8		3	R: Variable, +FS ADJ, 10K, 1/4W		
R6				R: Select		
R7				Same as R5		
R8	135486-8		2	R: FXD, 100K, 0.5%, WW		
R9				Same as R8		
R10				Same as R5		
R11	138170-8		1	R: FXD, 100Ω, 1/4W, CC		
R12	138174-8		2	R: FXD, 220Ω, 1/4W, CC		
R13				NOT USED		
R14	138178-8		1	R: FXD, 470Ω, 1/4W, 10%, CC		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A8R15	140895-8		4	R: FXD, 120K, 1/4W, 10%, CC		
R16				Same as R15		
R17	138198-8		2	R: FXD, 22K, 1/4W, 10%, CC		
R18	139544-8		2	R: FXD, 40.5K, PW2		
R19			1	R: Select		
R20	137847-8		3	R: Same as R20		
R21	139432-8		1	R: Variable, 100K, 1/4W, LIN ADJ		
R22				Same as R18		
R23				R: Select		
R24				Same as R20		
R25	137846-8		1	R: FXD, 190K, PW2		
R26				Same as R15		
R27				Same as R15		
R28				Same as R17		
R29				NOT USED		
R30	139173-8		2	R: FXD, 1.2K, 1/4W, 1%, met film		
R31				Same as R30		
R32				NOT USED		
R33	137923-8		2	R: FXD, 10K, PW2		
R34				Same as R33		
R35				Same as R20		
R36	138166-8		1	R: FXD, 47Ω, 1/4W, CC		
R37	138194-8		4	R: FXD, 10K, 1/4W, 10%, CC		
R38	138190-8		6	R: FXD, 4.7K, 1/4W, 10%, CC		
R39				NOT USED		
R40				Same as R3		
R41				NOT USED		
R42				NOT USED		
R43				Same as R37		
R44				Same as R38		
R45				Same as R37		
R46				Same as R38		
R47				Same as R37		
R48				Same as R38		
R49	129578-8		1	R: FXD, 20K, 1/4W, 10%, CC		
R50	138187-8		1	R: FXD, 2.7K, 1/4W, 10%, CC		
R51	138184-8		1	R: FXD, 1.5K, 1/4W, 10%, CC		
R52	138158-8		2	R: FXD, 10Ω, 1/4W, 10%, CC		
R53	138182-8		2	R: FXD, 1K, 1/4W, 10%, CC		
R54				Same as R52		
R55	137461-8		1	R: FXD, 4.75K, PW2		
R56				Same as R12		
R57				Same as R53		
R58				Same as R38		
R59				Same as R38		
A9	417494-2		1	Assembly, Active Filter (optional)		
	417499-2		1	PC Board		
A9C1	139506-8		2	C: .33μF		
C2				Same as C1		
C3	139507-8		1	C: .082μF		
C4	137834-8		1	C: 47pF		
C5				NOT USED		
C6	137454-8		2	C: 6.8μf, 20V		
C7				Same as C6		
A9CR1	137739-8		1	Scon: Diode 1N914		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A9IC1	137908-8		1	Scon: Integrated Circuit μA741		
A9Q1	137830-8		1	Scon: Transistor U1899E		
Q2	137854-8		1	Scon: Transistor U232		
A9R1	138926-8		3	R: FXD, 274K, 1% mF		
R2				Same as R1		
R3				Same as R1		
R4				NOT USED		
R5	137911-8		1	R: Variable 10K		
R6				NOT USED		
R7				NOT USED		
R8				NOT USED		
R9	138901-8		2	R: FXD, 150K, 1%mF		
R10				Same as R9		
R11	138817-8		1	R: FXD, 20K, 1%mF		
R12 thru R30				NOT USED		
R31	138719-8		1	R: FXD, 2K, 1% mF		
A10	419417-2		1	Preamplifier Assembly w/Guard Circuit		
	419416-2		1	PC Board		
A10C1	137834-8		3	C: 47pF, 500V		
C2				Same as C1		
C3				Same as C1		
C4	137833-8		2	C: 30pF, 500V		
C5				NOT USED		
C6				NOT USED		
C7	137837-8		1	C: .47μF, 50V		
C8				NOT USED		
C9	139614-8		4	C: .1μF		
C10				Same as C9		
C11	137836-8		1	C: .01μF, 200V		
C12	138025-8		1	C: .15μF, 20V		
C13	138498-8		2	C: 10μF, 20V		
C14				Same as C13		
C15				Same as C4		
C16	137974-8		2	C: .047μF, 50V		
C17				Same as C16		
C18				Same as C9		
C19				Same as C9		
C20	138721-8		1	C: 100pF		
-	139589-8		1	Contact Strip (9 Contacts)		
-	139590-8		1	Contact Strip (6 Contacts)		
-	139591-8		2	Guide Socket		
-	139592-8		2	Guide Pin		
A10CR1	137739-8		4	Scon: Diode IN914		
CR2				Same as CR1		
CR3				Same as CR1		
CR4	137832-8		1	Scon: Diode, Zener IN 5234B		
CR5				NOT USED		
CR6				Same as CR1		
A10IC1	137852-8		2	Scon: Integrated Circuit, LM301A		
IC2				Same as IC1		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A10Q1	410603-1		1	Scon: Transistor, Dual NPN		
Q2	278512-8		1	Scon: Transistor, NPN A1346		
Q3	403443-1		2	Scon: Transistor NPN A64IL		
Q4				Same as Q3 (matched pair)		
Q5	137800-8		2	Scon: Transistor, NPN 2N3904		
Q6				Same as Q5		
Q7	137830-8		1	Scon: Transistor, FET U1899E		
Q8	412068-1		2	Scon: Transistor, FET U1899E		
Q9				Same as Q8 (matched pair)		
Q10	137972-8		2	Scon: Transistor, FET UC1764		
Q11	137854-8			Scon: Transistor, FET U232		
A10R1	138198-8		1	R: FXD, 22K, 174W, 10%, CC		
R2	137841-8		3	R: Variable, 20K		
R3				NOT USED		
R4	135487-8		1	R: FXD, 200K, 1/3W, 0.5%, WW		
R5	139631-8		1	R: FXD, 190K, 1/3W, 0.5%, WW		
R6				NOT USED		
R7	140910-8		2	R: FXD, 510K, 1/4W, 1%, CF		
R8				Same as R7		
R9	140893-8		4	R: FXD, 100K, 1/4W, 1%, CF		
R10	Optional		1	R: FXD, SEL, 1/3W, 0.5%, CF		
R11				NOT USED		
R12	139587-8		2	R: FXD, 5K, 1/3W, 0.5%, WW		
R13				Same as R12		
R14				NOT USED		
R15	Optional		1	R: FXD, SEL, 1/3W, 0.5%, WW		
R16				Same as R9		
R17	140852-8		1	R: FXD, 2K, 1/4W, 1%, CF		
R18	137844-8		1	R: FXD, 33.5K, 1/4W, 1%, CF		
R19	140880-8		1	R: FXD, 30K, 1/4W, 1%, CF		
R20	140893-8			Same as R9		
R21				Same as R9		
R22	138230-8		1	R: FXD, 10MΩ, 1/4W, 10%, CC		
R23				Same as R2		
R24	140895-8			R: FXD, 120K, 1/4W, 1%, CF		
R25				Same as R24		
R26	138198-8		2	R: FXD, 22K, 1/4W, 10%, CC		
R27				NOT USED		
R28	138218-8		1	R: FXD, 1MΩ, 1/4W, 10%, CC		
R29				Same as R2		
R30				Same as R1		
R31	138206-8		2	R: FXD, 100K, 1/4W, 10%, CC		
R32	138194-8		3	R: FXD, 10K, 1/4W, 10%, CC		
R33				Same as R31		
R34				Same as R32		
R35				Same as R32		
R36				NOT USED		
R37				NOT USED		
R38				NOT USED		
R39				NOT USED		
R40	133801-8		1	R: FXD, 2K, 1/3W, 0.5%		
R41	138166-8		2	R: FXD, 47Ω, 1/4W, 10%, CC		
R42				Same as R41		
R43	129539-8			R: FXD, 470Ω, 1/4W, 5%, CC		

Table 6-1. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
A10A1	419420-2		1	Calibration Resistor Board Assembly		
-	419419-2		1	Printed Circuit Board		
$A1RX_1$	-			R: Selected Value, WW		
$A1RX_2$			1	R: Selected Value, WW		
-	139589-8		1	Contact Strip (9 contacts)	Elco	02-009-323-6-100
-	139590-8		1	Contact Strip (6 contacts)	Elco	02-006-323-6-100
-	139591-8		1	Guide Socket	Elco	62-5304-40-12
-	139592-8		1	Guide Pin	Elco	62-8202-40-12

PEAK AND HOLD CIRCUIT

SECTION I
GENERAL INFORMATION

1-1. GENERAL.

1-2. The Peak and Hold Circuit, Figure 1, is a plug-in PC board included with the instrument, if specified, as optional equipment. The circuit, which can be equipped with a preceding active filter, is utilized in BLH transducer measuring systems to monitor, hold, and display the highest point reached on a varying input signal. Typical applications include the monitoring of instantaneous shock loading, measurement of starting torque, drop tests, power surge levels, and destruct testing.

1-3. If specified, the active filter circuit is used to reduce certain undesired frequencies while leaving the useful signals relatively unchanged. The BLH active filter reduces to a negligible level signals induced by pulsating or cyclic loads. (I.e from agitators, vibrators, etc.) When used, the filter circuit is mounted on the peak and hold circuit board. Specifications for both the straight peak and hold circuit (417498-2) and the combination peak and hold/active filter circuit (417497-2) are listed in Table 1.

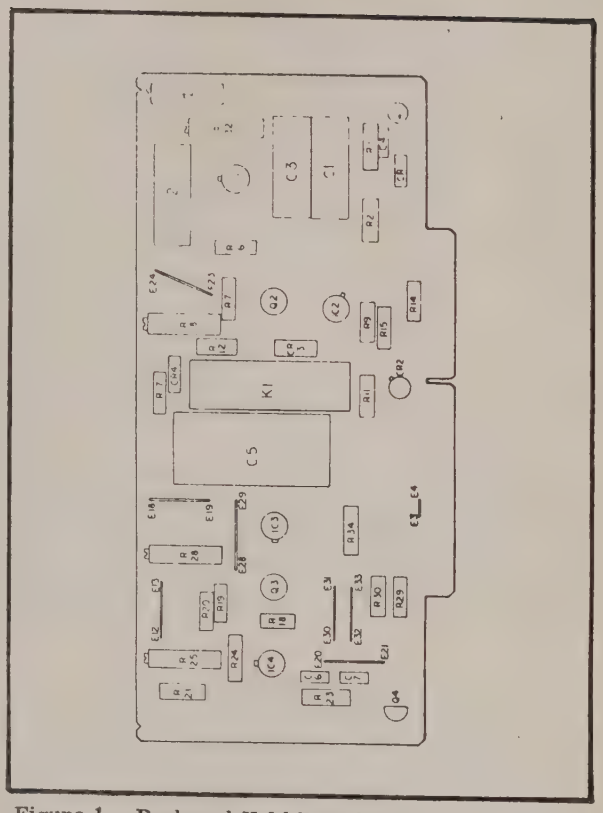


Figure 1. Peak and Hold Board With Active Filter.

Table 1. Specifications

	PEAK & HOLD
APERTURE TIME:	Analog aperture time is 10 milliseconds; however, when used with a Model 8000 or 450 equipped with automatic zeroing, aperture time must be 100 milliseconds.
	-NOTE- Aperture times may be reduced on special orders. Check special order instructions at front of manual.
HOLD TIME:	5 minutes to ± 0.05% or ± 0.5 mV/min.

Table 1. Specifications (Cont'd)

OPTIONAL ACTIVE FILTER

CUTOFF FREQUENCY (f_c):	0.3 Hz
RISE TIME: TO 99.9%:	6.2 sec.
ATTENUATION AT f_c:	3 db
ATTENUATION AT f = 5 Hz:	37 db
ATTENUATION AT f = 15 Hz:	80 db
MAXIMUM ROLLOFF:	60 db/decade
GAIN:	1.0 ± 0.05% up to 0.2 f_c
OFFSET VOLTAGE:	6 mV (adj. zero with trim pot)

SECTION II
INSTALLATION

1-4. The plug-in circuit is physically located in a special horizontal connector, J1, above the main circuit board in Model 450 Transducer Indicators as shown in Figure 2. All internal connections have been made at the factory. In addition, the board has been adjusted for the aperture time specified. Refer to the special order information at the front of the basic instrument manual. See Figure 3, Parts Location on board.

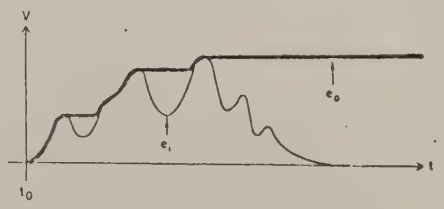
SECTION III
OPERATION

1-5. The peak and hold circuit is a form of sample/hold device in which the peak value of an input signal, once reached, is automatically held. A typical example is illustrated in Figure 4. For illustration purposes, the simplest sample/hold circuit is the switch and capacitor shown in Figure 5. Aperture time is the delay (reaction time) between the time the control logic tells S1 to open and the time this actually happens. Figure 6 illustrates the holding error caused by aperture time.

1-6. The simplest peak detector circuit is the diode and capacitor shown in Figure 7. When S1 is closed and S2 is open, diode D1 allows current to flow in one direction charging C1. When C1 becomes less than Eo, D1 becomes reversed biased and C1 holds its peak value. The circuit is reset when S1 is opened and S2 closed. In the hold mode, both S1 and S2 are opened so that C1 holds the desired peak value while ignoring other larger-value inputs.

1-7. The BLH peak and hold circuit, Figure 8, is composed of three operational amplifiers as shown. Signals passing through the amplifier train are stored in capacitor C5. On ascending signals, C5 contains the same voltage level as that appearing at the output of inverting amplifier IC4.

1-8. Whenever signal voltage drops below the highest point achieved during test or loading, the voltage stored in C5 becomes the signal level and the indicator display holds at the high reading. If subsequent signals rise above the high point, the indicator will unlock and track the signal until the signal decreases, at which time the indicator will again lock on the high point, as shown in the illustration below.



1-9. The dual FET Q3 is equivalent to a emitter follower, but with a much higher input impedance. It is utilized to prevent C5 from leaking. Diode CR2 is used to prevent a polarity reversal of the voltage applied to C5.

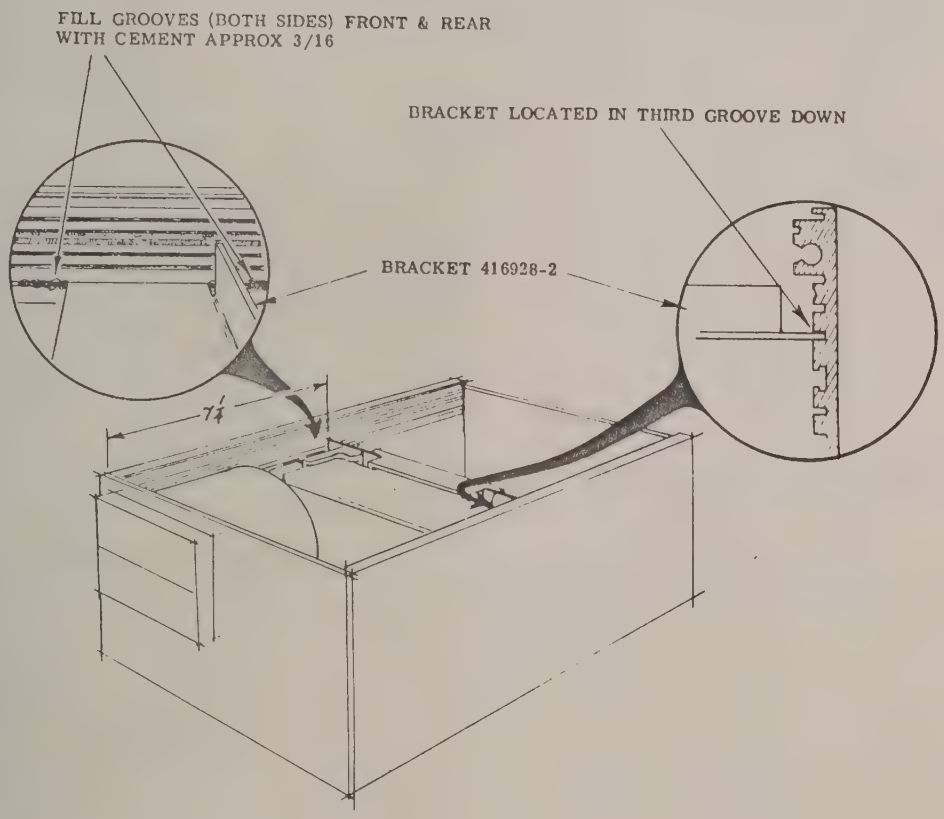


Figure 2. Board Location

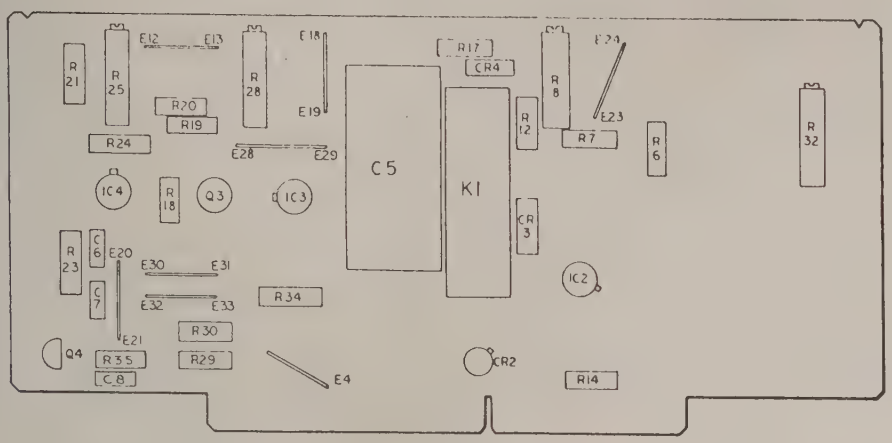


Figure 3. Parts Location

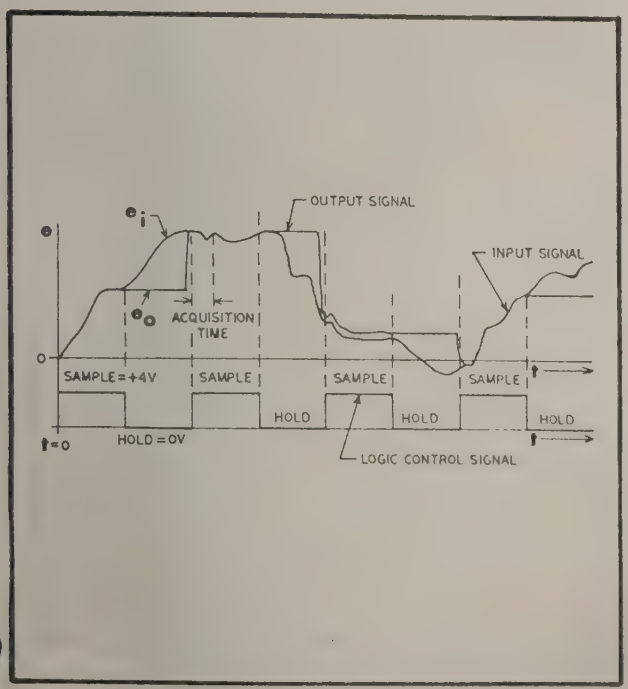


Figure 4. Input and Output Waveforms of a Typical Sample/Hold Module Circuit

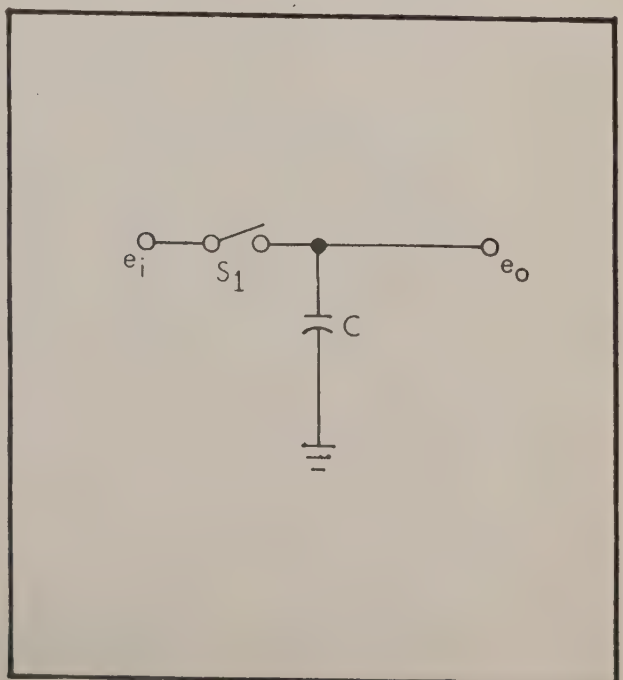


Figure 5. Basic Sample/Hold Circuit

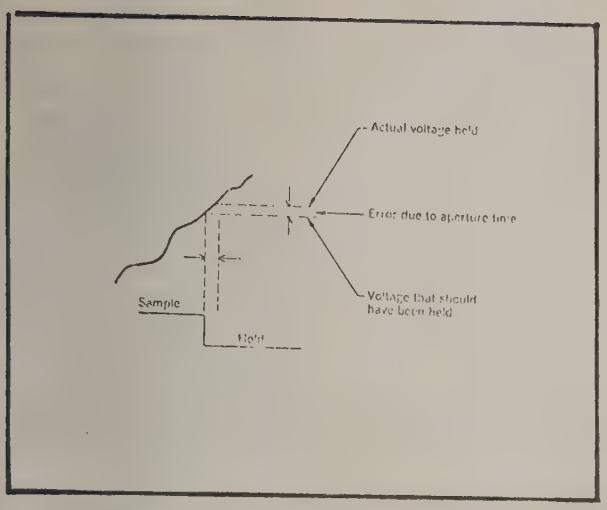


Figure 6. Aperture-Time Error

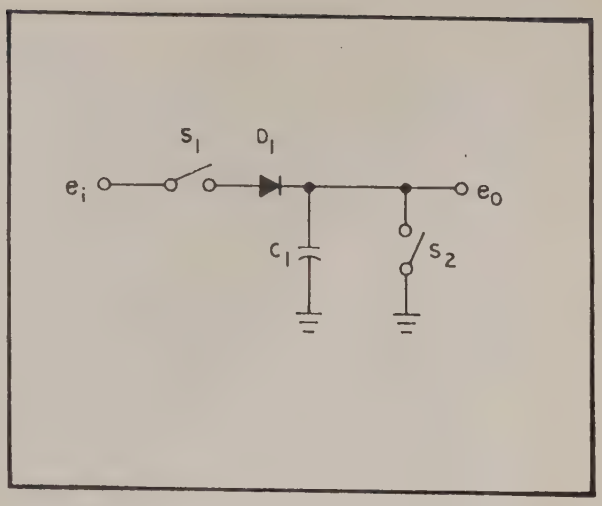


Figure 7. Basic Peak-Detector Circuit

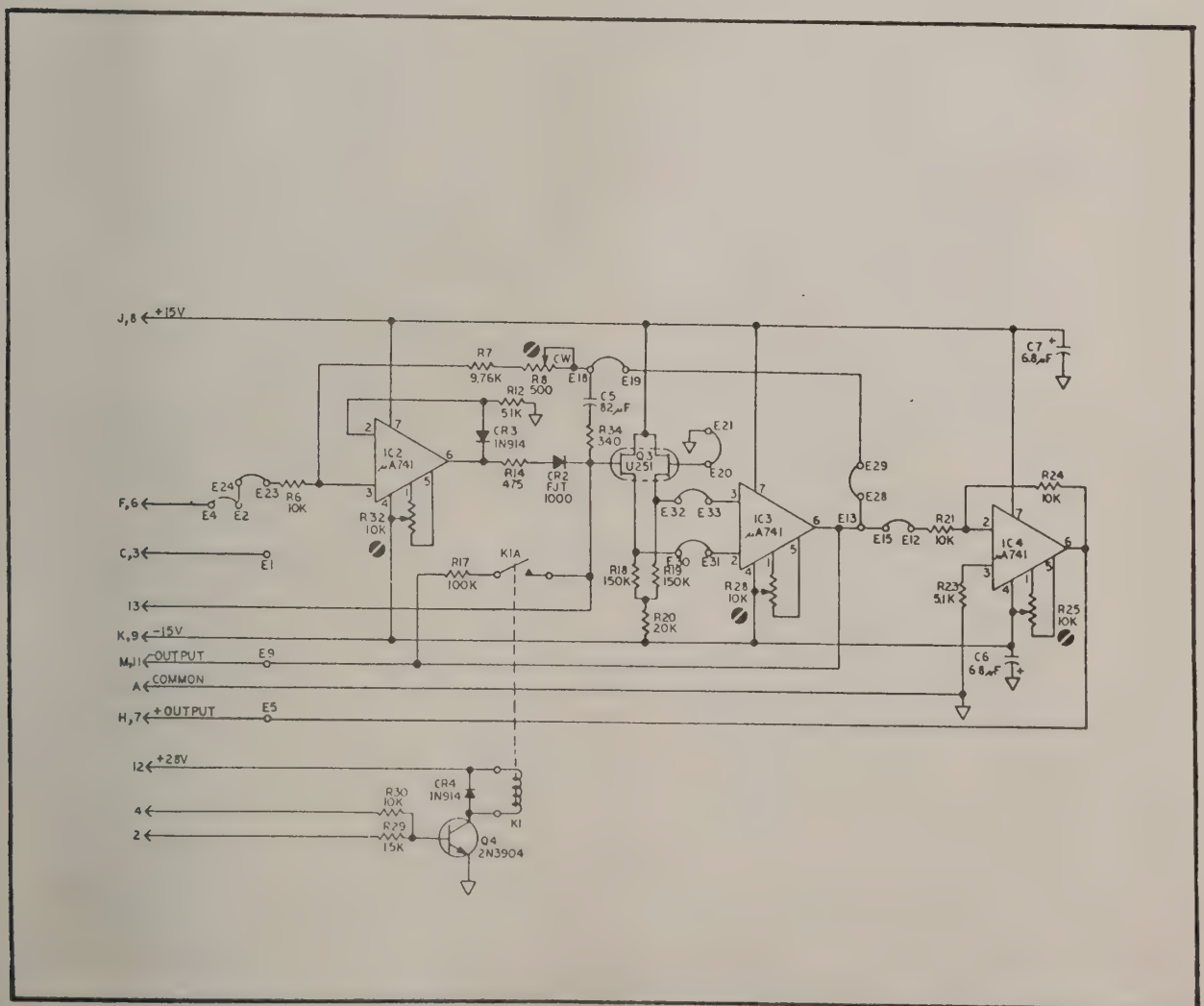


Figure 8. BLH Peak and Hold Circuit

1-10. When the peak and hold option is specified, the front panel of the 450 is modified to accept a NORM-PEAK toggle switch and a PEAK-RESET momentary pushbutton switch. Electrically, the switches are connected as shown on the Model 450 schematic diagram at the rear of this manual. When the NORM-PEAK switch is placed in the NORM position, the instrument operates as a standard Model 450. When the switch is placed in the PEAK position, the peak and hold circuit is activated and the instrument will display the highest reading obtained during a measurement sequence, the PEAK-RESET button is pressed to return the display to zero.

1-11. Active Filtering.

1-12. When used, the active filter, Figure 9, eliminates undesirable signal from low level pulsating or cyclic loads on the transducer before signal reaches the readout device. The circuit is basically a three-pole active filter. Q1 is a series junction FET, the gate of which is driven by the one-shot and accelerated by CR1 and C4. Q1 holds and maintains the signal input voltage which is further filtered by a conventional R-C network and applied to Q2 a dual FET. Q2 is similar to Q3 in the peak and hold circuit and is used to minimize signal losses.

1-13. Constant closed loop feedback is provided by IC1 an operational amplifier. IC1 also acts to restore the signal level originally presented to the input of the device, compensating for small signal losses incurred during filtration.

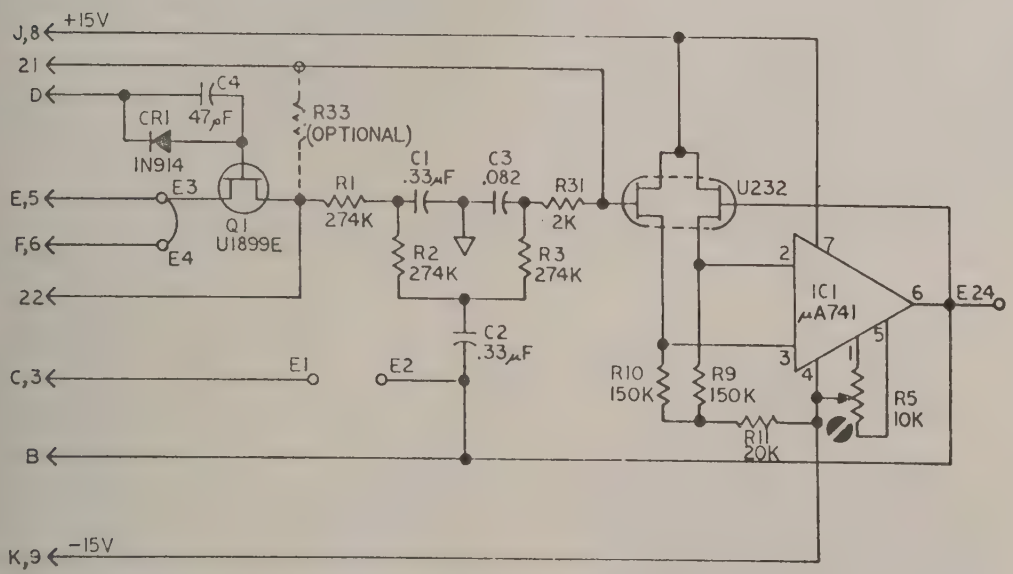


Figure 9. Active Filter

SECTION IV
MAINTENANCE

1-14. GENERAL.

1-15. The peak and hold circuit is a self-contained unit and does not require periodic maintenance.

1-16. TROUBLESHOOTING.

1-17. The basic tools for troubleshooting are the schematic diagram, Figure 6, and the theory information in Section II. If a malfunction occurs in the system, the most effective method of troubleshooting is to sectionalize the malfunction to a specific unit of the system before attempting to localize the problem to a particular circuit or stage as explained in the instrument manual. Every instrument manual lists test equipment recommended for troubleshooting the system.

1-18. Perform the troublshooting checks outlined in the instruction manual. If the trouble appears to be in the peak and hold circuit, proceed with the checks described in the following paragraphs.

Remove top cover as described in paragraph 5-4 of the 450 Manual.

Give the board a thorough visual inspection both in and out of the instrument and proceed to electrical check as necessary.

1-19. During the visual inspection look for loose components, loose wire connections, or similar conditions which would indicate a trouble source. Repair any faulty component or connection that would indicate a trouble source. Repair any faulty component or connection that is discovered during the visual inspection and check instrument performance before continuing the troubleshooting process.

1-20. If no obvious fault is discovered during the visual inspection, proceed with the electrical checkout, Use the schematic diagram as an aid in isolating the trouble to a particular component. The PC board can be checked in the chassis, but care must be taken when checking voltages to avoid shorting test probes to case.

1-21. Electrical Check.

1-22. Begin electrical check at power input pins J and 8 (+15V) and K and 9 (-15V) check that signal input is reaching the input pin (3) of IC2 through F and 6 of connector J1. Check that jumpers E2 through E4 and E23 and E24 are intact and are solidly connected. Check feedback potentiometer R8 by rotating arm through full travel while maintains output, dead areas, shorts, etc. will become apparent at the readout device. Peak and hold circuit output is at 6 of IC4 and at pins H and 7 of Connector J1.

1-23. Repair.

1-24. With the exception of superficial defects (loose wires, foil breaks, etc) , and easily replaced items, repair of printed circuit boards is not practical. A defective board should be replaced with an assembly known to be operating correctly and the malfunctioning unit shipped to a BLH Sales/Service Office for repair or replacement. If board replacement is not feasible, and individual components must be replaced in the field, proceed according to the following paragraphs.

1-25. BOARD REMOVAL AND REPLACEMENT. The board is easily located when the top cover of the instrument is removed. The amplifier board is held in connector J1 with two spring wire hold-downs. Remove by snapping the hold-down outward toward the sides of the instrument, grasping the board by the edges and drawing straight forward. Before removing the PC board, disconnect instrument power to avoid the possibility of accidentally shorting adjacent board components.

CAUTION

WHEN INSPECTING BOARDS DO NOT TOUCH EDGE CONNECTORS OR THE ETCHED CIRCUIT BOARD. DO NOT TRACE SIGNAL PATHS OR TEST COMPONENTS FOR LOOSENESS WITH A PENCIL AS IT IS POSSIBLE TO INTRODUCE HIGH IMPEDANCE LEAKAGE PATHS WITH GRAPHITE.

When replacing, avoid touching printed circuit trace and insert PC board, component side up, into Connector J1. Press in firmly and snap wire hold-downs into notches in top of board. All internal connections are automatically made when board is installed.

1-26. SERVICING PC BOARDS. Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low power soldering iron (50watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick drying acetate base cement having good electrical insulating qualities. A break in the copper should be repaired by soldering a short length of tinned copper wire across the break. Use only high quality rosin core solder when repairing etched circuit boards. Never use paste flux. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer. When replacing components with multiple mounting pins such as transistors and integrated circuits, it will be necessary to lift each pin slightly, working around the component several times until it is free.

SECTION V

REPLACEABLE PARTS

1-27. INTRODUCTION.

1-28. This section contains information for ordering and identifying replacement parts. Table 2 lists in alphanumeric order by reference designator and provides the following information on each part:

a. BLH part number.

b. Total quantity used in the instrument (TQ column Quantity listed where item first appears on list.

c. Recommended spares for year application in a remote location (or 2000 hours). RS column.

1-29. ORDERING INFORMATION.

1-30. To obtain replacement parts, address order or inquiry for parts to the nearest BLH Sales/Service Office. (See list at rear of instruction manual) or direct to BLH. Identify parts by BLH part numbers.

1-31. To order parts not listed in this section, provide the following:

a. Model number of instrument.

b. Serial number of the unit.

c. Description of the part including function and location.

Table 2. Replaceable Parts

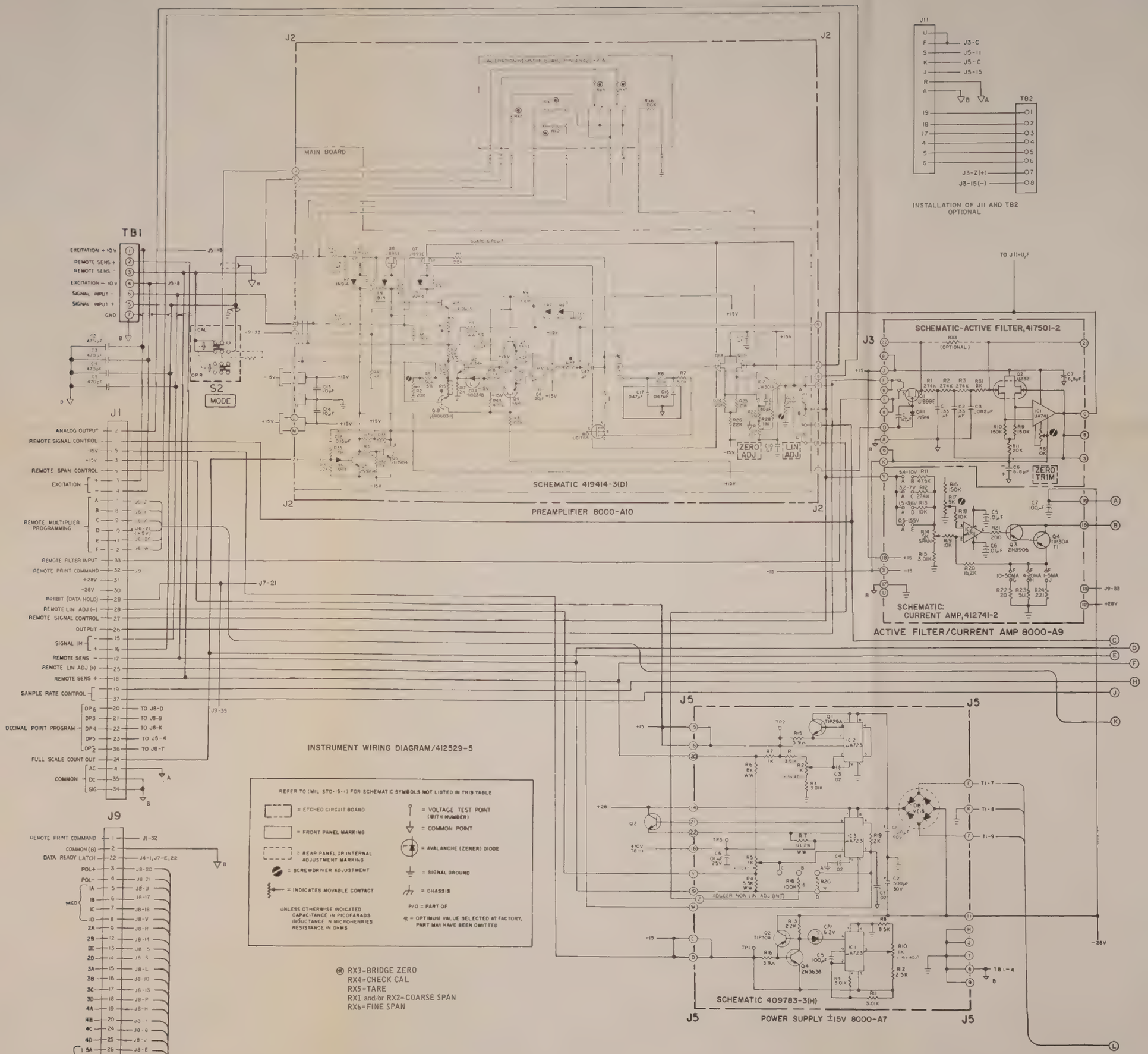
Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
END ITEM	420931-3		1	Assembly, Peak and Hold Circuit PC Board		
	417499-2		1	PC Board		
C1 thru C4				NOT USED		
C5	139499-8		1	C: 0.82μF		
C6	137454-8		2	C: 6.8μF, 20Vdc		
C7				Same as C6		
CR1				NOT USED		
CR2	139508-8		1	Diode: FJT 1000		
CR3	137739-8		2	Diode: IN914		
CR4				Same as CR3		
IC1				NOT USED		
IC2 thru IC4	137908-8		3	Integrated Circuit: UA741		
Q1 thru Q2				NOT USED		
Q3	139493-8		1	Scon: FET, U251		
Q4	127800-8		1	2N3904		
K1	139492-8		1	Relay: Electronic Instrument AE501H03		
R1 thru R5				NOT USED		
R6	138788-8		4	R: FXD, 10K MF, 1%		
R7	138787-8		1	R: FXD, 9.76K, MF, 1%		
R8	138542-8		1	R: VAR, 500Ω		
R9 thru R11				NOT USED		
R12	139233-8		2	R: FXD, 5.1K, MF, 1%		
R13			1	R: FXD, 100K, MF, 1%		

Table 2. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
R14	138659-8		1	R: FXD, 475Ω, MF, 1%		
R15, R16				NOT USED		
R17	139359-8		1	R: FXD, 100K, MF, 1%		
R18	138901-8		2	R: FXD, 150K, MF, 1%		
R19				Same as R18		
R20	138817		1	R: FXD, 20K, MF, 1%		
R21				Same as R6		
R22				NOT USED		
R23, R24				Same as R6		
R25	137911-8		2	R: VAR, 10K		
R26, R27				NOT USED		
R28				Same as R25		
R29	138707-8		1	R: FXD, 1.5K, MF, 1%		
R30				Same as R6		
R31				NOT USED		
R32				Same as R25		
R33				NOT USED		
R34	138645-8		1	R: FXD, 340Ω, MF, 1%		
END ITEM	421111-3		1	Assembly, Active Filter W/Peak and Hold		
	417499-2		1	PC Board		
C1	139506-8		1	C: 0.33μF		
C2				Same as C1		
C3	139507-8		1	C: 0.082μF		
C4	137834-8		1	C: 47pF		
C5	139499-8		1	C: 0.82μF 100Vdc		
C6	137454-8		2	C: 6.8μF, 20Vdc		
C7				Same as C6		
CR1	137739-8		3	Scon: Diode IN914		
CR2	139508-8		1	Scon: Diode FJT 1000		
CR3				Same as CR1		
CR4				Same as CR1		
Q1	137830-8		1	Scon: FET μ1899E		
Q2	137854-8		1	Scon: μ232		
Q3	139493-8		1	Scon: FET μ251		
Q4	137800-8		1	Scon: 2N3904		
K1	139492-8		1	Relay, Electronic Instruments AE501H03		
R1, R2, R3	138926-8		3	R: FXD, 274K, MF, 1%		
R4				NOT USED		
R5	137911-8		1	R: VAR, 10K, MF,		
R6	138788-8		4	R: FXD, 10K, MF		
R7	138787-8		1	R: FXD, 9.76K, MF		
R8	138542-8		1	R: VAR, 500Ω		
R9	138901-8		3	R: FXD, 150K, MF, 1%		
R10				Same as R9		
R11	138817-8		2	R: FXD, 20K, MF, 1%		
R12	139233-8		2	R: FXD, 5.1K, MF, 1%		
R13				NOT USED		
R14	138659-8		1	R: FXD, 475Ω, MF, 1%		
R15, R16				NOT USED		
R17	139359-8		1	R: FXD, 100K, MF		
R18, R19				Same as R9		
R20				Same as R11		
R21				Same as R6		
R22				NOT USED		

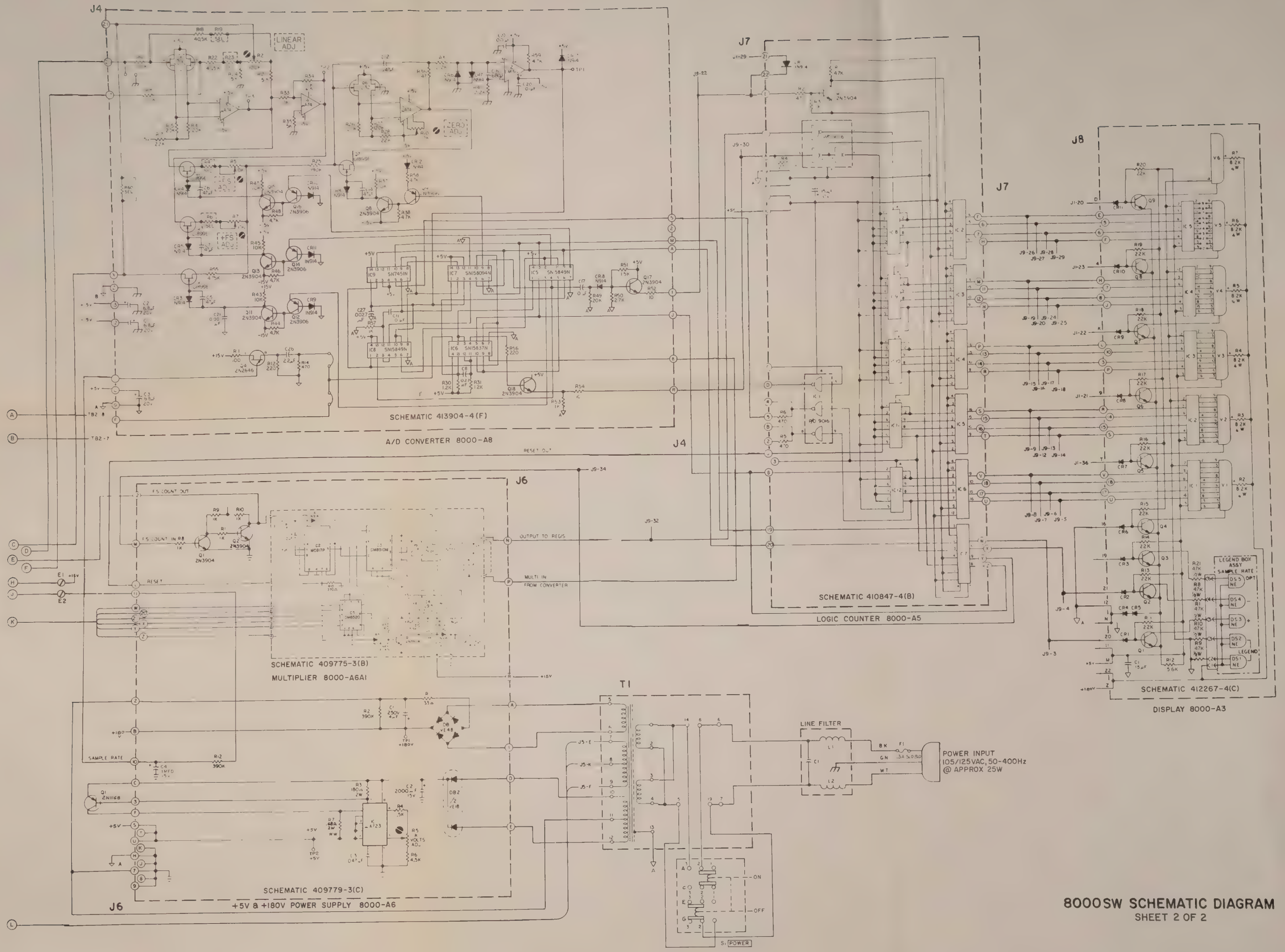
Table 3. Replaceable Parts

Ref Desig	BLH Part No.	RS	TQ	Description	Mfr	Mfr Part No.
R23				Same as R12		
R24				Same as R6		
R25				Same as R5		
R26, R27				NOT USED		
R28				Same as R5		
R29	138707-8		1	R: FXD, 1.5K, MF		
R30				Same as R6		
R31	138719-8		1	R: FXD, 2K, MF, 1%		
R32				Same as R5		
R33				NOT USED		
R34	138645-8		1	R: FXD, 340Ω, MF		



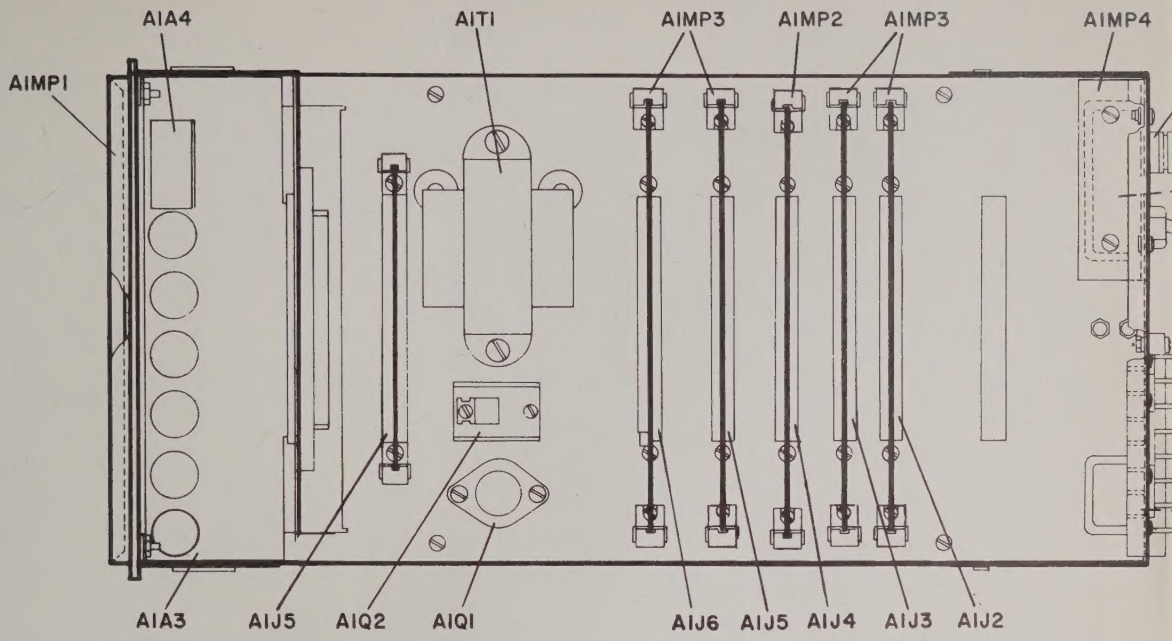
8000SW SCHEMATIC DIAGRAM

SHEET 1 OF 2



8000SW SCHEMATIC DIAGRAM

SHEET 2 OF 2



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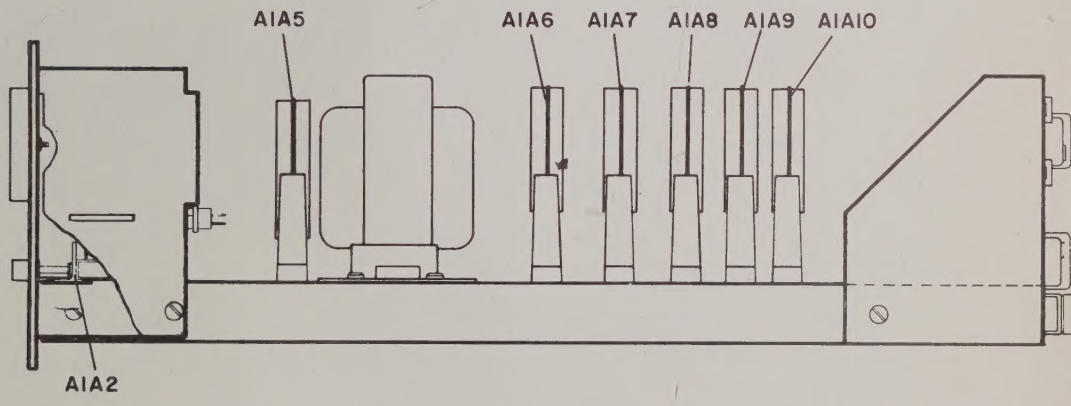
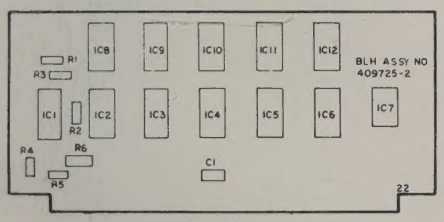
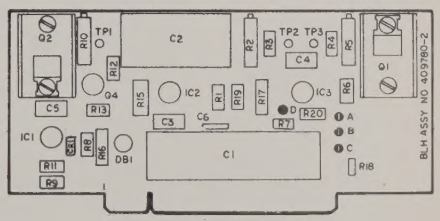
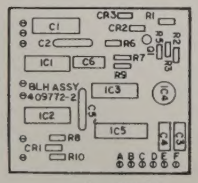




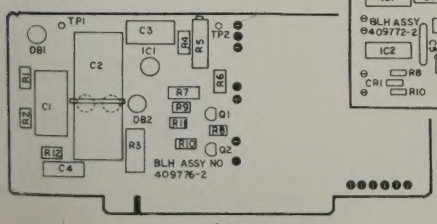
A5
COUNTER



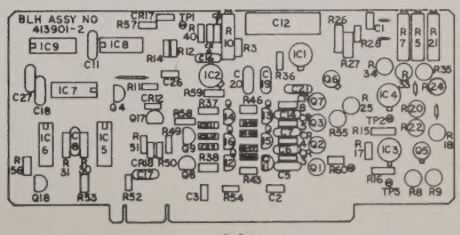
A7
±15V POWER SUPPLY



A6A1
MULTIPLIER

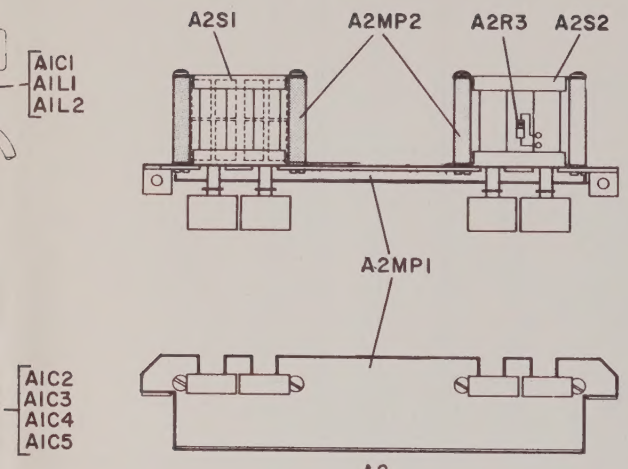


A6
+5/18.0V POWER SUPPLY

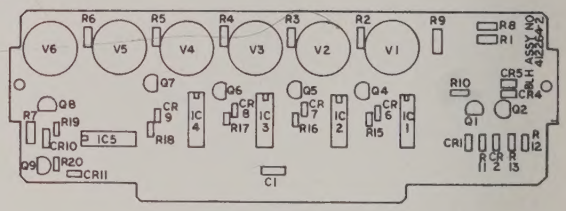


A8
CONVERTER

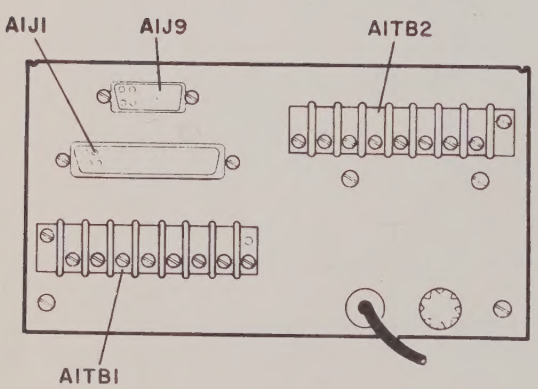
AIFI
AIXFI

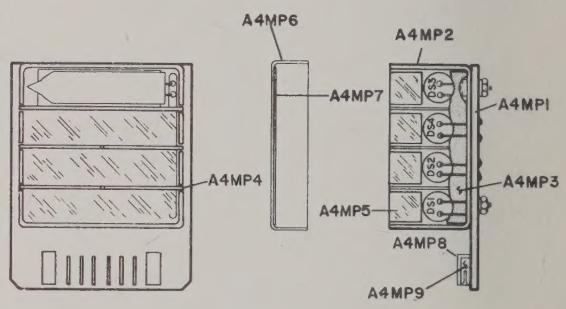


A2

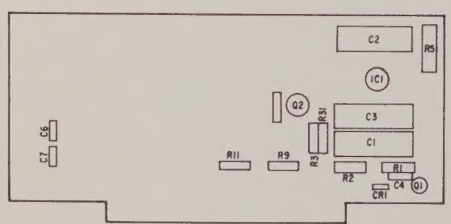


A3
DISPLAY

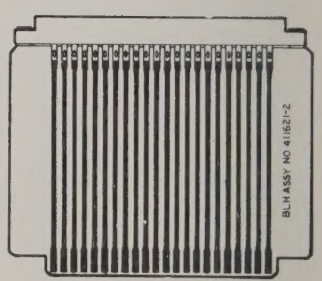




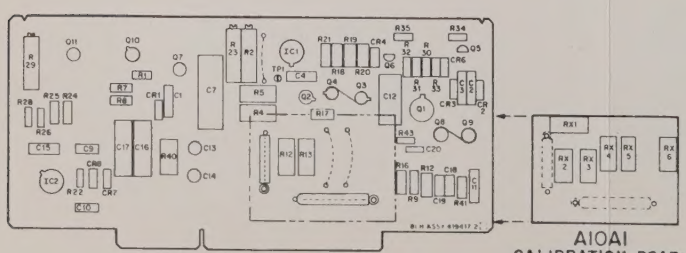
A4
LEGEND BOX



A9
ACTIVE FILTER



A11
EXTENDER BOARD



A10
PREAMPLIFIER

A10A1
CALIBRATION BOARD